



October 23, 2013

Ms. Catherine Guynn  
ERS III, Office of Environmental Remediation  
West Virginia Department of Environmental Protection  
601 57th Street SE  
Charleston, WV 25304

RE: Quality Carriers, Inc. Property – VRP #11680  
Site Assessment Report – Addendum

Dear Ms. Guynn:

On behalf of Quality Carriers, Inc. (QCI), as successor to Chemical Leaman Tank Lines, I have enclosed for your review two hard copies of the replacement pages for the Voluntary Remediation Program Site Assessment Report (SAR), originally dated December 27, 2012. These replacement pages constitute an addendum to the SAR and reflect revisions and additional data collected pursuant to the West Virginia Department of Environmental Protection (WVDEP) comments dated January 30, 2013, subsequent discussions with WVDEP staff, and the Site Assessment Work Plan Addendum dated April 2013 and approved by the WVDEP by letter dated May 1, 2013.

Each set of replacement pages includes the following:

- Revised binder cover and spine inserts;
- Revised Table of Contents;
- Revised text (complete);
- Revised Figures 2, 4, 9 (old 8), 10 (old 9), 11 (old 10), and 12 (old 11);
- New Figures 5A, 5B, and 5C (insert following Figure 5);
- New Figures 6A and 6B (insert following Figure 6);
- New Figures 8, 8A, 8B, and 8C (insert following Figure 7);
- Revised Tables 7 through 30 and 32;
- Additional sheets for Appendix C-5 (WTA-3 and WTA-4 Boring Logs);
- Additional sheets for Appendix D (MW-108R Drilling and Construction Logs); and,
- Additional sheets for Appendix E (MW-108R Sampling Logs).

Also included are two sets of two CDs. Each set includes the complete SAR, as revised, and the laboratory reports for samples collected pursuant to the work plan addendum.

To assist in your review of the SAR Addendum, below is a brief description of the changes made to the document, relative to the WVDEP comments.

### Section Specific Comments

1. References to the intermittent drainage ditch have been added to the text of Sections 4.6 and 4.7 on page 11.
2. Pages 11-12, Section 4.7 have been revised to provide clarification and the date of the drilling of the borings and installation of the monitoring wells.
3. Page 14, Section 4.8.2 has been revised to Title 47, Section 12.
4. Table 13 has been revised to include additional information supporting the TEQ calculations.
5. Pages 60-61, Section 7.1.4 have been revised to provide clarification.
6. The WVDEP comment does not request a specific change. As suggested, should evaluation of the potential impact of contaminated groundwater on surface water be conducted in the future, the approach described in the comment will be used.
7. Page 57, Section 6.5.3. Pursuant to discussions with the WVDEP, the observation that PAH compounds were not detected in samples collected during previous groundwater monitoring events at the site has been added to provide additional support for the interpretation that PAH compounds reported in samples under the VRP sampling program reflect naturally-occurring aquifer matrix material, in the form of suspended sediment in samples from monitoring wells that had not been sampled since December 2005.

### Figures

1. Figures 2, 4, and 10 have been revised to indicate the approximate position of the intermittent drainage ditch east of the Wastewater Treatment Area. Also, Figure 11 (former Figure 10) has been revised to include the water level elevation for the WTT-1 monitoring well and an elevation contour line to depict the general hydraulic relationship between the Wastewater Treatment Area and the lower portion of the site.
2. For those sampling areas with a greater number of sample locations and associated analytical results (i.e., the DBA, TSS, and WTA areas), additional figures are provided showing the analytical results that exceeded de minimis values for each general soil sampling depth interval. The additional figures are Figures 5A, 5B, and 5C for the DBA; Figures 6A and 6B for the TSS; and, Figures 8A, 8B, and 8C for the WTA.

Comments

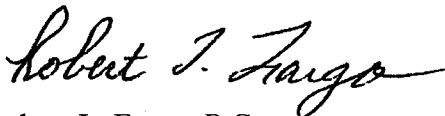
1. Pursuant to discussions with the WVDEP, monitoring well MW-108R was installed to replace former well MW-108, which could not be located prior to the first round of assessment under the Voluntary Remediation Program conducted during 2012. The position and construction of the replacement well was as requested by the WVDEP. The replacement well was sampled twice and the data are included in the SAR Addendum. Irrespective of the source of VOCs reported at the MW-106 monitoring well, data for the MW-108R well indicate that VOCs are not migrating off-site from this area at concentrations that exceed de minimis values.
2. See response to Comment 1, above.
3. See response to Comment 1, above.
4. In accordance with the Work Plan Addendum, two additional soil sampling locations in the Wastewater Treatment Area were determined with the concurrence of the WVDEP. Analytical results for samples from these locations (WTA-3 and WTA-4) are included in revised Tables 24 and 25, and were included in the preparation of Figures 8A, 8B, and 8C.
5. References to USEPA Regional Screening Levels (RSLs) have been removed from all data tables. The text of the SAR Addendum has been revised to reflect screening comparisons to VRP de minimis values only.

In accordance with the project schedule contained in the Voluntary Remediation Agreement, as modified, the Human Health & Ecological Risk Assessment will be submitted to the WVDEP within three months following agency approval of the SAR Addendum.

Please contact me with any questions.

Respectfully,

SAIC Energy, Environment & Infrastructure, LLC



Robert L. Fargo, P.G.  
Senior Environmental Specialist  
WV LRS #20

RLF:dlp  
Enclosure

cc: J. Rakitsky (QDI) w/enc.  
Bonni Kaufmann (Holland & Knight) w/enc.  
Erich Weissbart (USEPA) w/enc.



**VOLUNTARY REMEDIATION PROGRAM  
SITE ASSESSMENT REPORT  
QUALITY CARRIERS, INC. PROPERTY  
INSTITUTE, WEST VIRGINIA**

**VRP #11680**

**SAIC Project 4501020069**

**Prepared for:**

**Quality Distribution, Inc.  
102 Pickering Way, Suite 105  
Exton, PA 19341**

**December 27, 2012  
Revised October 23, 2013**

Voluntary Remediation Program  
Site Assessment Report  
Quality Carriers, Inc. Property  
Institute, West Virginia

VRP #11680

SAIC Project 4501020069

Prepared for:

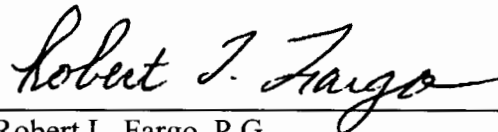
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December 27, 2012  
Revised October 23, 2013

Respectfully submitted,

A handwritten signature in black ink, reading "Robert L. Fargo". The signature is written in a cursive style with a horizontal line underneath it.

Robert L. Fargo, P.G.  
Senior Environmental Specialist  
West Virginia Licensed Remediation Specialist #20

# TABLE OF CONTENTS

Page

<b>EXECUTIVE SUMMARY .....</b>	<b>1</b>
<b>1.0 INTRODUCTION.....</b>	<b>1</b>
<b>2.0 SITE DEFINITION AND PHYSICAL SETTING .....</b>	<b>3</b>
<b>3.0 DEVELOPMENT AND OPERATIONAL HISTORY .....</b>	<b>5</b>
<b>4.0 HISTORY OF REMEDIATION AND DATA COLLECTION.....</b>	<b>6</b>
4.1 Buried Drum Excavation .....	6
4.2 Ex-Situ Bio-Remediation of Excavated Soil .....	6
4.3 Post-Closure Care Groundwater Monitoring .....	7
4.4 In-Situ Groundwater Remediation .....	9
4.5 Polymer Spill .....	10
4.6 Wastewater Treatment Area Tank Seepage .....	11
4.7 Disposal Pit Area – AOC No. 1 .....	11
4.8 Summary of Pre-Existing Data .....	12
4.8.1 Soil .....	12
4.8.2 Groundwater .....	13
4.8.2.1 General Chemistry .....	15
4.8.2.2 Metals.....	16
4.8.2.3 VOCs.....	16
4.8.2.4 SVOCs .....	18
4.8.2.5 PCBs/Pesticides/Herbicides/Dioxins/Furans .....	19
<b>5.0 SCOPE OF VRP SITE ASSESSMENT INVESTIGATION .....</b>	<b>20</b>
5.1 Objectives .....	20
5.2 Scope of Investigation.....	20
5.2.1 Review of Historical Land Use.....	21
5.2.2 Soil Sampling.....	21
5.2.2.1 Former Drum Burial Area.....	21
5.2.2.2 Treated Soil Stockpile.....	22
5.2.2.3 Polymer Spill Area.....	23
5.2.2.4 Wastewater Treatment Plant Area .....	23
5.2.2.5 Disposal Pit Area – AOC No. 1 .....	24
5.2.3 Installation of Temporary Groundwater Sampling Points .....	25
5.2.4 Groundwater Sampling .....	25
5.2.5 Groundwater Flow Mapping.....	26
5.2.6 Addendum.....	27
5.2.6.1 Disposal Pit Area – AOC No. 1 .....	27
5.2.6.2 Sludge Release Area .....	27
5.2.6.3 MW-108 Replacement Well Installation/Sampling.....	27
<b>6.0 DESCRIPTION OF SITE CONDITIONS .....</b>	<b>30</b>
6.1 Historical Land Use .....	30

6.1.1	Reconnaissance .....	30
6.1.2	Aerial Photographs.....	30
6.1.3	Topographic Maps .....	31
6.2	Hydrology .....	32
6.3	Geology/Hydrogeology.....	33
6.3.1	Unconsolidated .....	33
6.3.2	Bedrock.....	34
6.3.3	Groundwater Occurrence and Flow .....	34
6.4	Analytical Results for Soil .....	37
6.4.1	Former Drum Burial Area.....	38
6.4.1.1	Metals (Table 8).....	38
6.4.1.2	VOCs (Table 9).....	39
6.4.1.3	SVOCs (Table 10).....	40
6.4.1.4	Pesticides/Herbicides (Table 11) .....	40
6.4.1.5	PCBs (Table 12).....	41
6.4.1.6	Dioxins/Furans (Table 13).....	41
6.4.2	Treated Soil Stockpile.....	41
6.4.2.1	Metals (Table 14).....	42
6.4.2.2	VOCs (Table 15).....	43
6.4.2.3	SVOCs (Table 16).....	43
6.4.2.4	Pesticides/Herbicides (Table 11) .....	43
6.4.2.5	PCBs (Table 12).....	44
6.4.2.6	Dioxins/Furans (Table 13).....	44
6.4.3	Polymer Spill Area.....	44
6.4.3.1	Metals (Table 17).....	44
6.4.3.2	VOCs (Table 18).....	45
6.4.3.3	SVOCs (Table 19).....	45
6.4.4	Wastewater Treatment Plant Area .....	45
6.4.4.1	Metals (Table 20).....	46
6.4.4.2	VOCs (Table 21).....	46
6.4.4.3	SVOCs (Table 22).....	46
6.4.5	Disposal Pit Area – AOC No. 1 .....	46
6.4.5.1	Metals (Table 23).....	47
6.4.5.2	VOCs (Table 24).....	47
6.4.5.3	SVOCs (Table 25).....	48
6.4.5.4	Pesticides/Herbicides (Table 11) .....	48
6.4.5.5	PCBs (Table 12).....	48
6.4.5.6	Dioxins/Furans (Table 13).....	48
6.4.6	Summary of Soil Results .....	48
6.4.6.1	Metals.....	49
6.4.6.2	VOCs.....	49
6.4.6.3	SVOCs .....	50
6.4.6.4	Pesticides/Herbicides .....	50
6.4.6.5	PCBs .....	50
6.4.6.6	Dioxins/Furans.....	51
6.5	Analytical Results for Groundwater .....	51

6.5.1	Metals (Table 26)	52
6.5.2	VOCs (Table 27)	54
6.5.3	SVOCs (Table 28)	56
6.5.4	Pesticides/Herbicides (Table 29)	57
6.5.5	PCBs (Table 30)	58
<b>7.0</b>	<b>CONTAMINANT FATE AND TRANSPORT</b>	<b>59</b>
7.1	Soil	59
7.1.1	Erosion/Storm Water Runoff	59
7.1.2	Erosion/Particulate Emissions	59
7.1.3	Leaching	60
7.1.4	Volatilization	60
7.1.5	Vapor Intrusion	61
7.2	Groundwater	61
7.2.1	Migration of Dissolved Constituents	61
7.2.2	Volatilization from Groundwater	65
<b>8.0</b>	<b>PRELIMINARY CONCEPTUAL SITE MODEL</b>	<b>66</b>
8.1	Contaminants of Interest (COI)	66
8.1.1	Soil	67
8.1.2	Groundwater	69
8.2	Potential Exposure Pathways – Human Receptors	70
8.2.1	Soil	71
8.2.2	Groundwater	71
8.3	Potential Exposure Pathways – Ecological Receptors	72



## FIGURES

Figure 1, Site Location Map .....	Following Text
Figure 2, Site Survey.....	Following Text
Figure 3, Site Features .....	Following Text
Figure 4, Base Map .....	Following Text
Figure 5A, Results Exceeding De Minimis Values — Former Drum Burial Area Surface Soil Samples .....	Following Text
Figure 5B, Results Exceeding De Minimis Values — Former Drum Burial Area Mid-Depth Soil Samples.....	Following Text
Figure 5C, Results Exceeding De Minimis Values — Former Drum Burial Area Deep Soil Samples .....	Following Text
Figure 6A, Results Exceeding De Minimis Values — Treated Soil Stockpile Shallow Soil Samples .....	Following Text
Figure 6B, Results Exceeding De Minimis Values — Treated Soil Stockpile Deep Soil Samples .....	Following Text
Figure 7, Polymer Spill Area Soil Sample Locations.....	Following Text
Figure 8, Disposal Pit Area Soil Sample Locations.....	Following Text
Figure 8A, Results Exceeding De Minimis Values — Disposal Pit Area Shallow Soil Samples .....	Following Text
Figure 8B, Results Exceeding De Minimis Values — Disposal Pit Area Mid-Depth Soil Samples.....	Following Text
Figure 8C, Results Exceeding De Minimis Values — Disposal Pit Area Deep Soil Samples .....	Following Text
Figure 9, Generalized Geologic Cross-Section.....	Following Text
Figure 10, Bedrock Rose Diagram.....	Following Text
Figure 11, Groundwater Elevation Contour Map — June 17, 2013 .....	Following Text
Figure 12, Conceptual Site Model .....	Following Text

## TABLES

Table 1, Summary of Analytical Results for Confirmation Soil Samples, Former Drum Excavation Area .....	Following Text
Table 2, Summary of Historical Analytical Results for Groundwater – General Chemistry Parameters .....	Following Text
Table 3, Summary of Historical Analytical Results for Groundwater – Appendix IX Detected Metals .....	Following Text
Table 4, Summary of Historical Analytical Results for Groundwater – VOCs.....	Following Text
Table 5, Summary of Historical Analytical Results for Groundwater – SVOCs .....	Following Text
Table 6, Summary of Historical Analytical Results for Groundwater – Pesticides, Herbicides, Dioxins, and Furans.....	Following Text
Table 7, Summary of Groundwater Elevation Measurements.....	Following Text
Table 8, Analytical Results for Metals in Soil, Drum Burial Area.....	Following Text
Table 9, Analytical Result for VOCs in Soil, Drum Burial Area .....	Following Text
Table 10, Analytical Results for SVOCs in Soil, Drum Burial Area .....	Following Text

## TABLES (continued)

Table 11, Analytical Results for Pesticides/Herbicides in Soil .....	Following Text
Table 12, Analytical Results for PCBs in Soil.....	Following Text
Table 13, Analytical Results for Dioxins/Furans in Soil .....	Following Text
Table 14, Analytical Results for Metals in Soil, Treated Soil Stockpile .....	Following Text
Table 15, Analytical Results for VOCs in Soil, Treated Soil Stockpile .....	Following Text
Table 16, Analytical Results for SVOCs in Soil, Treated Soil Stockpile.....	Following Text
Table 17, Analytical Results for Metals in Soil, Polymer Spill Area .....	Following Text
Table 18, Analytical Results for VOCs in Soil, Polymer Spill Area.....	Following Text
Table 19, Analytical Results for SVOCs in Soil, Polymer Spill Area.....	Following Text
Table 20, Analytical Results for Metals in Soil, Wastewater Treatment Plant Seepage Area.....	Following Text
Table 21, Analytical Results for VOCs in Soil, Wastewater Treatment Plant Seepage Area.....	Following Text
Table 22, Analytical Results for SVOCs in Soil, Wastewater Treatment Plant Seepage Area.....	Following Text
Table 23, Analytical Results for Metals in Soil, AOC No. 1.....	Following Text
Table 24, Analytical Results for VOCs in Soil, AOC No. 1 .....	Following Text
Table 25, Analytical Results for SVOCs in Soil, AOC No. 1 .....	Following Text
Table 26, Analytical Results for Metals in Groundwater .....	Following Text
Table 27, Analytical Results for VOCs in Groundwater .....	Following Text
Table 28, Analytical Results for SVOCs in Groundwater.....	Following Text
Table 29, Analytical Results for Pesticides/Herbicides in Groundwater.....	Following Text
Table 30, Analytical Results for PCBs in Groundwater.....	Following Text
Table 31, Summary of Groundwater/Surface Water Analysis .....	Following Text
Table 32, Summary of Contaminants of Interest Analysis for Soil .....	Following Text

## APPENDICES

Appendix A, Survey Description.....	Following Text
Appendix B-1, Historic Aerial Photographs.....	Following Text
Appendix B-2, Historic Topographic Maps.....	Following Text
Appendix C-1, DBA Boring Logs .....	Following Text
Appendix C-2, TSS Boring Logs.....	Following Text
Appendix C-3, PSA Boring Logs .....	Following Text
Appendix C-4, WWTP Boring Logs .....	Following Text
Appendix C-5, WTA Boring Logs.....	Following Text
Appendix D, TMP Logs.....	Following Text
Appendix E-1, Groundwater Sample Logs – August 2012 .....	Following Text
Appendix E-2, Groundwater Sample Logs – September 2012.....	Following Text
Appendix E-3, MW-108R Groundwater Sampling Logs .....	Following Text
Appendix F, Reconnaissance Photographs .....	Following Text
Appendix G, MW Well Logs.....	Following Text
Appendix H, Data Validation Documents .....	Following Text

## **EXECUTIVE SUMMARY**

The Quality Carriers, Inc. (QCI) site (the Site) is comprised of slightly more than 142 acres, located along Route 25 in Institute, West Virginia, approximately 4.5 miles west of Charleston and about 1,500 feet north of the Kanawha River. Approximately 10 acres of the Site have been developed. The developed area is roughly an elongated rectangle, oriented east-west along the north side of Route 25. The remainder of the Site is comprised of steep, heavily wooded hillsides.

Much of the area along the north side of the Kanawha River is heavily industrialized. There is no groundwater use at the Site and there is no known use of groundwater for potable supply purposes in the vicinity of the Site. The Site and surrounding area is served by the West Virginia American Water Company public water supply system.

Since 1963, the Site has been used as a bulk liquid chemical trucking terminal and tanker cleaning facility. In response to allegations of on-site burial of drummed waste from facility operations, an investigation and subsequent excavation of drummed waste and associated soil was performed in 1995, in accordance with an agreement with the West Virginia Department of Environmental Protection (WVDEP). Subsequent ex-situ treatment of excavated soil was performed under the terms of a Consent Agreement with the WVDEP and a Post-Closure Care Permit under the Resource Conservation and Recovery Act (RCRA) ("Permit"). As part of the remediation work, a stockpile of treated soil was constructed near the eastern end of the developed portion of the Site and is still present.

Under the Permit and later modifications, additional site characterization and in-situ remediation of groundwater were conducted (August 2003 until October 2005), and a schedule of periodic groundwater sampling was established. The final groundwater monitoring event, demonstrating attainment of the cleanup goals at all compliance wells, was conducted in December 2005. A report documenting attainment of the West Virginia Groundwater Protection Standards (WVGPS) at all compliance wells was submitted to the WVDEP in January 2006.

A Voluntary Remediation Agreement (VRA), pursuant to the West Virginia Voluntary Remediation and Redevelopment Act (VRRRA), was executed for the Site on February 29, 2012. Site characterization activities under the VRA, pursuant to an approved Site Assessment Work Plan (SAWP), were performed during the period from August through December 2012. Based on comments to the Site Assessment Report, an addendum to the SAWP was prepared and supplemental soil and groundwater sampling was performed from May to July 2013. In all soil samples were collected from 26 locations in five areas of the Site where releases to soil are known or suspected to have occurred. A total of 67 soil samples were collected and analyzed for selected metals, volatile organic compounds (VOCs), and semi-volatile organic compounds (SVOCs). Selected soil samples were also analyzed for pesticide/herbicide compounds, polychlorinated biphenyls (PCBs), and dioxin/furan compounds.

Certain metals, VOCs, SVOCs, and pesticide/herbicide compounds were reported above leaching-based de minimis values (DMVs), which conservatively assume that groundwater beneath the Site is used for potable supply purposes. None of the results for any parameters analyzed exceeded risk-based DMVs. Except for two VOCs in two samples, all results for soil samples from the treated soil stockpile were below Land Disposal Restrictions (LDRs) under RCRA.

During the VRA site assessment, groundwater samples were collected on two occasions from ten monitoring wells and three temporary sampling points. Groundwater samples were analyzed for selected metals, VOCs, SVOCs, pesticide/herbicide compounds, and PCBs. Certain metals, VOCs, and SVOCs were reported at concentrations above groundwater DMVs, predominantly at wells adjacent to or near the former drum burial area. Concentrations decrease rapidly with distance away from the drum burial area. In nearly all cases, concentrations are similar to or lower than historical values. Except for the MW-102 monitoring well, none of the samples from locations along or near the downgradient boundary of the Site exhibited concentrations above DMVs.

At MW-102, one VOC was reported at concentrations near its DMV, and PCB Aroclor 1260 was reported somewhat above its DMV. The analytical results for groundwater indicate minimal

potential for migration of contaminants in groundwater beyond the downgradient boundary of the Site at concentrations exceeding DMVs.

The predominant migration pathway for contaminants of interest (COI) in soil is by leaching to groundwater. Volatilization of VOCs from soil and migration to ambient air or into a hypothetical future building may also occur, if no engineering control or mitigation measure is in place. Exposure to COI in soil could occur by direct contact with soil, incidental ingestion of soil, and/or inhalation of VOCs that volatilize from soil. The most likely receptors are daily site workers or excavation workers that could be involved in a future construction or maintenance project. These possible exposure pathways will be further evaluated in the Site-Specific Risk Assessment to be prepared under the VRA.

The predominant migration pathway for COI in groundwater is transport of dissolved COI according to groundwater flow conditions. Concentrations of COI in groundwater decrease rapidly with distance away from the drum burial area. Available data indicate the potential for contaminant concentrations that are above DMVs to persist far downgradient of the drum burial area is minimal. Also, there is no groundwater use in the area. Very conservative analysis indicates that the potential for impacts to surface water in the Kanawha River as a result of groundwater discharge to the river is negligible.

Volatilization of VOCs from groundwater and migration to ambient air or into a hypothetical future building may also occur, if no engineering control or mitigation measure is in place. Exposure to COI in groundwater could occur by direct contact and/or incidental ingestion of groundwater and by inhalation of VOCs by an excavation worker who encounters shallow groundwater. These possible exposure pathways will be further evaluated in the Site-Specific Risk Assessment to be prepared under the VRA.

## 1.0 INTRODUCTION

Since 1963, the Quality Carriers, Inc. (QCI) site (the Site) that is the subject of this report has been used as a bulk liquid chemical trucking terminal and tanker cleaning facility. In response to allegations of on-site burial of drummed waste from facility operations, an investigation and subsequent excavation of drummed waste and associated soil was performed in 1995, in accordance with an agreement with the West Virginia Department of Environmental Protection (WVDEP). Subsequent ex-situ treatment of excavated soil was performed under the terms of a Consent Agreement with the WVDEP and a Post-Closure Care Permit under the Resource Conservation and Recovery Act (RCRA) ("Permit").

Under the Permit and later modifications, additional site characterization and in-situ remediation of groundwater were conducted (August 2003 until October 2005), and a schedule of periodic groundwater sampling was established. The second permit modification also identified certain monitoring wells as compliance wells and specified that remediation and monitoring could be terminated when West Virginia Groundwater Protection Standards (WVGPS) for site-related parameters were met at each well for six consecutive semiannual monitoring events (three-year period). The final groundwater monitoring event, demonstrating attainment of the WVGPS at all compliance wells, was conducted in December 2005. The report documenting attainment of the WVGPS at all compliance wells was submitted to the WVDEP in January 2006.

A Voluntary Remediation Agreement (VRA) pursuant to the Voluntary Remediation and Redevelopment Act (VRRRA) was executed for the Site on February 29, 2012. The VRA and subsequent Modification No. 1 require preparation and/or execution of the following:

- Site Assessment Work Plan (SAWP) (no later than First Quarter 2012),
- Site Assessment Report (SAR) (no later than Fourth Quarter 2012),
- Human Health and Ecological Risk Assessment (no later than First Quarter 2013), and
- Remedial Action Work Plan (no later than Third Quarter 2013).

The SAWP was approved by the WVDEP by letter dated July 6, 2012.

A SAR was prepared and submitted to the WVDEP by letter dated December 27, 2012. The agency provided QCI with comments to the SAR dated January 30, 2013. Based on those comments and discussions with the WVDEP, a SAWP Addendum was prepared and subsequently approved by the WVDEP. Supplemental soil and groundwater sampling under the Addendum was performed during the period from May to July 2013. The remainder of this report provides a description of Site background information, including investigation, remediation, and monitoring activities that preceded the VRA, a description of the work performed under the SAWP and Addendum, and the results and interpretations from that work.

## 2.0 SITE DEFINITION AND PHYSICAL SETTING

The QCI property is located at 38° 23' 40" north latitude and 81° 47' 45" west longitude, along Route 25 in Institute, West Virginia, approximately 4.5 miles west of Charleston on the north side of State Route 25 (the "Site"). The southern boundary of the Site is from approximately 700 feet to about 1,500 feet north of the Kanawha River. The Site appears on the Saint Albans, West Virginia, United States Geological Survey (USGS), 7.5-minute topographic quadrangle (**Figure 1**).

For purposes of implementing the Voluntary Remediation Program (VRP) at the subject site, the Site is hereby defined as 142.305 acres, comprised of 6 parcels which are as follows:

- Parcel 1: Deed book 2159, page 315 (0.502 acres)
- Parcel 2: Deed book 2159, page 315 (0.622 acres)
- Parcel 3: Deed book 1480, page 648 (0.254 acres)
- Parcel 4: Deed book 1542, page 445 (118.19 acres)
- Parcel 5: Deed book 1480, page 643 (21.93 acres)
- Parcel 6: Deed book 1480, page 665 (0.807 acres)

A map depicting the site boundaries is provided as **Figure 2**. A legal description is provided in **Appendix A**.

Approximately 10 acres of the Site have been developed/improved. The improved area is roughly an elongated rectangle, oriented east-west along the north side of Route 25 (**Figure 3**). The remainder of the Site is comprised of steep, heavily wooded hillsides. Other than some limited timber removal that reportedly occurred at some time in the past, this heavily wooded area of the Site is undeveloped and has never been used by site operators.

Land surface elevation of the developed portion of the Site averages around 600 feet above mean sea level (msl), with a slight slope to the south (toward Route 25). The majority of the developed portion of the Site is gravel-covered and used for truck parking.



The wooded hillsides to the north rise steeply to elevations over 1,000 feet above msl. A localized surface-water drainage basin extends from the south-central area of the Site, upslope into the highland area to the north and northeast. The USGS topographic map does not indicate a perennial stream in this drainage basin, and reports of long-time employees at the Site indicate that the drainage carries only intermittent wet weather runoff. This runoff is carried beneath the developed portion of the Site through a 48-inch-diameter pipe.

Much of the area along the north side of the Kanawha River is heavily industrialized. Immediately to the south of the Site, between Route 25 and the river, is a large wastewater treatment plant for an adjacent industrial complex. Groundwater in the area of the Site is not known to be used for potable supply purposes, and the area is served by the West Virginia American Water Company public water supply system.

### **3.0 DEVELOPMENT AND OPERATIONAL HISTORY**

Ownership of the Site prior to 1942 is unknown. From 1942 to 1962, the Site was owned by Union Carbide, the former owner of the industrial complex and wastewater treatment facility to the south of Route 25 from the Site. During this time, the Site was undeveloped. In 1963, the Site was purchased by Chemical Leaman Tank Lines, Inc. (CLTL), which constructed the existing facility building and a wastewater treatment plant for use in the cleaning of tanker trucks used to haul bulk liquid chemicals. In 1993, Quala Systems, Inc. (QSI) began operating the commercial tank wash business.

In 1998, Chemical Leaman Corporation (owner of CLTL and QSI) merged with Montgomery Tank Lines, Inc. (MTL). Operations at the facility continued under the names Quality Carriers, Inc. and Quala Systems, Inc., both indirect subsidiaries of Quality Distribution, Inc. (QDI). Under this structure, QSI continued as the operating entity for the tank washing operations. Currently, the Site is owned by QCI, which has no company operations at that location. Trucking operations were managed by an affiliate partner, a third-party company called Transtech Logistics (TTL), under contract to QCI until July 29, 2012. Effective on that date, a new affiliate, LMI, assumed management of the transportation operations. The tank washing operation was operated by TTL, using another company name, but under agreement with QSI, until August 1, 2012, when an independent third party company called Qualawash Holdings, LLC replaced TTL. On or about February 15, 2013, Qualawash Holdings, LLC ceased operations of the tank wash.

The facility is an active bulk chemical trucking terminal, consisting of parking areas, dispatch offices, and a maintenance shop. The tanker cleaning operation has been discontinued. The wastewater treatment plant used to treat nonhazardous wastewater may be operated on an as-needed basis going forward to primarily handle and treat rain water that contacts former operating areas. Discharge from the treatment plant is to the Kanawha River, under a National Pollutant Discharge Elimination System (NPDES) permit held by QSI.

## **4.0 HISTORY OF REMEDIATION AND DATA COLLECTION**

### **4.1 Buried Drum Excavation**

In response to allegations by former employees regarding the on-site burial of drummed waste material, the WVDEP and CLTL agreed to conduct an assessment of the then CLTL facility in the mid-1990s. From August 1995 through November 1995, approximately 500 drums of waste and impacted soil were excavated from an area measuring approximately 50 feet by 100 feet, just east of the facility building (see **Figure 4**). For purposes of this report, this area is referred to as the former Drum Burial Area (DBA). Approximately 750 tons of excavated material was sent off-site for disposal. In addition, an estimated 2,400 cubic yards (yd<sup>3</sup>) of impacted soil was placed in a series of eight cells (bio-cells) constructed on-site for biological treatment.

### **4.2 Ex-Situ Bio-Remediation of Excavated Soil**

Approximate locations of the eight bio-cells are shown on **Figure 4**. The bio-cells were constructed by excavating to a depth of approximately two feet within the footprint of the cell. The excavated soil was used to construct a berm around each cell. The floor of each cell was sloped to promote drainage to a collection sump. An impermeable liner was placed on the bottom of the cell, and a drainage layer consisting of six inches of sand and gravel was laid on the liner. Filter fabric was placed over the drainage layer, and the cell was then filled with soil to be remediated. A system of polyvinyl chloride (PVC) piping was installed within the soil and connected to a blower to supply air to the soil, and an enzymatic solution was applied to the soil.

During a period from late July through early August 1997, the eight original bio-cells were consolidated into two cells, which were operated for an additional six weeks, in accordance with a plan approved by the WVDEP. Confirmation sampling of the soil in the cells was then performed, and the results were submitted to the WVDEP for review in October 1997. In November 1997, the bio-cells were closed in accordance with a plan approved by the WVDEP. Soil that exceeded Land Disposal Restrictions (LDRs) under the RCRA regulations was sent for off-site disposal. Soil that met LDRs was moved to a treated soil stockpile (TSS) constructed at

the eastern end of the Site (**Figure 4**). Reportedly, the TSS contains approximately 2,200 yd<sup>3</sup> of soil. In connection with the construction of the stockpile, the land was cleared and leveled, a liner was placed, soil was placed on top and graded, and seeding was applied, and erosion controls were implemented.

Closure of the bio-cells included backfilling of the areas with clean soil from the Site and regrading. More detailed information related to the operation, sampling, and consolidation of the bio-cells is provided in the following reports by Weavertown Environmental Group:

- *Biocell Sampling and Analysis Report, CLTL Terminal, Institute, West Virginia* (March, 1997);
- *Work Plan for Ex-Situ Bioremediation, Chemical Leaman Truck Lines Terminal, Institute, West Virginia* (April 18, 1997); and
- *Closure Report for Biocells, Chemical Leaman Truck Lines Terminal, Institute, West Virginia* (November 21, 1997).

### **4.3 Post-Closure Care Groundwater Monitoring**

Prior to the remediation activity at the DBA, the QCI facility was classified as a small quantity generator (SQG) of hazardous waste. The QSI facility was a large quantity generator (LQG). In September 1995, CLTL was issued an Emergency Permit for Temporary Management of Hazardous Waste by the WVDEP. The permit expired on November 25, 1995, and was replaced by a second emergency permit, which expired on January 29, 1996.

The remainder of the remediation was conducted under the terms of a Consent Order executed between WVDEP and CLTL on March 6, 1997. The Consent Order required CLTL to obtain a RCRA Post-Closure Care Permit for the DBA. That permit (WVR000001719) was issued by the WVDEP on June 30, 1999. The permitted area was divided into three areas, as follows:

- Buried drum excavation area (0.10 acre);
- Bioremediation area (0.56 acre); and
- Treated soil stockpile (0.11 acre).

During August 1999, six groundwater monitoring wells, designated MW-101 through MW-106, were installed at the Site. Monitoring well locations are shown on **Figure 4**. As part of this work, one soil sample from each monitoring well borehole was analyzed for volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). The first sampling of the monitoring wells was performed in September 1999, with samples being analyzed for parameters specified in condition IV-C-2 of the Post-Closure Care Permit, which included total organic carbon (TOC), VOCs, SVOCs, and total lead.

Because certain parameters were reported at concentrations above the maximum concentrations established in the permit, the monitoring wells were resampled in October 1999, for analysis of parameters specified in 40 Code of Federal Regulations (CFR) 264, Appendix IX, pursuant to condition IV-C-4-a-I of the permit. Routine sampling of monitoring wells MW-101 through MW-106 was conducted again in December 1999, March 2000, and June 2000, with analyses for TOC, VOCs, SVOCs, and total and dissolved lead.

In response to the detection of certain parameters at concentrations above limits established in the permit, WVDEP issued Modification No. 1 to the Post-Closure Care Permit in May 2000. The modification provided for the installation of four additional monitoring wells (MW-107 through MW-110, see **Figure 4**) to further assess groundwater conditions beneath the Site. The four additional wells were installed in July 2000. This well installation program also included the following:

- Collection of one soil sample from the vadose zone at each well location for analysis of permeability, volumetric air content, volumetric water content, total porosity, soil bulk density, and moisture content;
- Installation of one soil boring adjacent to MW-101 to collect a soil sample for TOC analysis;

- Hydraulic conductivity (slug) tests on all of the groundwater monitoring wells;
- Collection of samples from all groundwater monitoring wells for analysis of parameters which affect the natural attenuation process, including dissolved oxygen, nitrate, ferrous iron, sulfate, and methane;
- Collection of samples from all groundwater monitoring wells for analysis of VOCs, SVOCs, dissolved and total lead, pH, conductivity, and TOC;
- Baseline risk evaluation to identify potential exposure pathways; and
- Modeling for each compound detected in groundwater on-site to assess the potential maximum extent of downgradient migration.

Results from the additional site characterization work completed under Modification No. 1 were provided to the WVDEP in the form of a Site Characterization Report/Corrective Action Plan (SAIC, May 2002), submitted in conjunction with a request for modification (No. 2) to the Post-Closure Care Permit. The scope and implementation of the proposed Corrective Action Plan were negotiated during the period from May 2002 through March 2003.

During the period from June 2000 through May 2003, routine semiannual sampling of all groundwater monitoring wells continued, with analyses for VOCs, SVOCs, nitrate-nitrogen, sulfate, and total and dissolved lead. During June 2001, ferrous iron was also analyzed, and during May 2003, ferrous iron and dissolved oxygen were analyzed.

#### **4.4 In-Situ Groundwater Remediation**

In January 2003, WVDEP issued Modification No. 2 to the Post-Closure Care Permit for the DBA. Among other things, the modification authorized the implementation of in-situ bioremediation of groundwater in the DBA using the introduction of bio-amendments to stimulate naturally occurring microorganisms. Five injection wells were installed in August 2003 to supply oxygen to the shallow groundwater using the in-situ oxygen curtain (ISOC) technology. In-situ groundwater treatment continued until October 2005.

Each month during the first six months of operation of the groundwater remediation system, samples were collected from wells MW-104, MW-105, MW-106, MW-108, and MW-109 for analysis of the following system operating parameters:

- TOC
- Ammonia-nitrogen
- Nitrate-nitrogen
- Sulfate
- Temperature
- pH
- Conductivity
- Dissolved oxygen

During the period from May 2003 through December 2005, routine semiannual groundwater sampling continued, with all site monitoring wells being sampled and analyzed for TOC, VOCs, SVOCs, nitrate-nitrogen, sulfate, total and dissolved lead, ferrous iron, and dissolved oxygen.

Modification No. 2 to the site Post-Closure Care Permit also identified monitoring wells MW-102, MW-103, MW-107, MW-108, and MW-109 as compliance wells and specified that remediation and monitoring could be terminated when WVGPS for site-related parameters were met at each of these monitoring wells for six consecutive semiannual monitoring events (three-year period). Operation of the groundwater remediation system was discontinued in October 2005. The final groundwater monitoring event, demonstrating attainment of the WVGPS at all compliance wells, was conducted in December 2005. The report documenting attainment of the WVGPS at all compliance wells was submitted to the WVDEP in January 2006.

#### **4.5 Polymer Spill**

According to facility personnel, approximately five years ago, a small volume of product called FLOC2000 was released from a tanker trailer that was parked in the gravel-covered lot west of

the facility buildings (see **Figure 2**). FLOC2000 is powdered polymer that turns to a gel consistency when it contacts water. When released to the ground, the FLOC2000 turned to a gel, so the release was limited to a localized area. Facility personnel indicate that the WVDEP was notified of the release, and the material and a small volume of underlying soil were removed for off-site disposal. The area affected by the spill was estimated to be 5 feet by 20 feet.

#### **4.6 Wastewater Treatment Area Tank Seepage**

Recently, seepage occurred from the Chemical Batch Reactor (CBR) tank in the facility's wastewater treatment area. The CBR tank collects all water from the facility's tanker cleaning operations. The primary function of the tank is precipitation and solids removal. Water in the tank is first treated with sulfuric acid to reduce the pH to approximately five. The pH is then returned to near neutral through the addition of sodium hydroxide. A flocculent and aluminum sulfate are added to promote solids removal. The CBR tank is an aboveground tank constructed of concrete panels. The seepage occurred along one or more seams in the tank and flowed along the concrete floor of a small building in which the tank is located and onto the ground outside the building. The area of soil affected by the seepage is estimated to be four feet by five feet. The seepage did not reach the intermittent drainage ditch that carries seasonal surface water flow from the highland area to the north and is located adjacent to the east side of the wastewater treatment area.

#### **4.7 Disposal Pit Area – AOC No. 1**

Former employees of the QCI facility identified an area near the east side of the facility's wastewater treatment plant as one of two locations where drums may have been buried (the other area was the confirmed DBA described in Section 4.1). This area is between the wastewater treatment facility and the intermittent drainage ditch. In response, the WVDEP requested a subsurface investigation of the area. An investigation was performed on behalf of CLTL by Vector Enterprises, Inc. in late 1994/early 1995. As part of the investigation, two soil borings were drilled, and three monitoring wells were installed in the area, although currently, only two



monitoring wells can be located. Hereafter, these monitoring wells will be designated WWT-1 through WWT-2.

On October 27, 2009, representatives of Tetra Tech EC, Inc. (Tetra Tech), and United States Environmental Protection Agency (USEPA) conducted a RCRA site visit at the QCI facility. Tetra Tech issued a Final RCRA Site Visit Report dated March 31, 2010. The report identified an area near the wastewater treatment facility as Area of Concern (AOC) No. 1. According to the Tetra Tech report, analyses of soil samples indicated no exceedence of Toxicity Characteristic Leaching Procedure (TCLP) priority pollutants; however, the WVDEP indicated that additional characterization of this area was warranted.

## **4.8 Summary of Pre-Existing Data**

Through the activities described in Section 4.1 through 4.7, extensive sampling and analysis of soil and groundwater at the Site were conducted. The following sections provide summaries of the resulting analytical results. It is noted that these data were not validated pursuant to the VRP and are being presented in this section of the SAR solely as background information to support the Scope of Site Investigation described in Section 5.

### **4.8.1 Soil**

The drum excavation project conducted during 1995 is described in the report titled "Closure Summary, Chemical Leaman Tank Lines, Institute, WV" (Vector Enterprises, 1996). The excavation work utilized a systematic grid approach to the removal of drums and associated soil. The depth of the excavation reportedly ranged from 5 feet to 18 feet. As part of the excavation project, confirmation soil samples were collected from various sidewall and base locations within the excavation grid system. The samples were reported as "composite" samples. A total of 38 confirmation samples were collected, with the samples being analyzed for varying combinations of gasoline-range and diesel-range organic compounds (GRO and DRO, respectively), VOCs, and SVOCs. A summary of compounds reported in the confirmation samples is provided as **Table 1**.

Where applicable, **Table 1** indicates the VRP de minimis values (DMVs) for industrial direct contact and for migration to groundwater. Although the DMVs are not directly applicable to composite samples, the results provide a general indication of residual concentrations in soil in the area of the excavation at that time.

VOCs that were reported at concentrations above their respective DMV in one or more samples included methylene chloride, chlorobenzene, and trichloroethene (TCE). SVOCs that were reported above their respective DMV in one or more samples were:

- naphthalene,
- bis(2-ethylhexyl)phthalate,
- hexachlorobenzene,
- 2-chlorophenol,
- 1,2,4-trichlorobenzene, and
- N-nitrosodiphenylamine.

It is noted that all of the results exceeding a DMV were for the migration to groundwater pathway. None of the composite sample results exceeded the risk-based, industrial direct contact value.

#### **4.8.2 Groundwater**

Groundwater conditions associated with the former DBA, bio-cell areas, and the TSS were investigated through the installation and sampling of 10 groundwater monitoring wells (MW-101 through MW-110). Monitoring wells MW-101 through MW-106, installed during August 1999, were sampled 17 times during the period from September 1999 through December 2005. Monitoring wells MW-107 through MW-110, installed during July 2000, were sampled 12 times during the period from September 2000 through December 2005. Monitoring wells MW-101 and MW-110 are regarded to be hydraulically upgradient from areas of the Site where remediation activities have taken place (see **Figure 4**) and, therefore, are regarded to represent background water quality conditions.

It is noted that two additional monitoring wells are located near the wastewater treatment plant (see **Figure 4**). The history of installation, and construction details for these wells, as well as the nature of analytical results for any samples from these wells, are uncertain. For purposes of this report, these wells have been designated WWT-1 through WWT-2.

The parameters or parameter groups analyzed on groundwater samples from the MW series wells and the number of times that each parameter or group was analyzed are as follows:

Total Organic Carbon:	17 events
General Chemistry:	12 events
Lead:	6 events
Metals:	1 event
VOCs (8260):	17 events
SVOCs (8270):	17 events
Pesticides/Herbicides:	1 event
Dioxins/Furans:	1 event
40CFR264 (Appendix IX):	1 event

Summaries of these monitoring data are provided in the following tables:

Table 2:	TOC/General Chemistry
Table 3:	Metals
Table 4:	VOCs
Table 5:	SVOCs
Table 6:	Pesticides/Herbicides/Dioxins/Furans

Each of these categories of water quality data is discussed in the following sections. For purposes of establishing the scope of available data and describing pre-existing conditions at the site, limited interpretation of the data is provided. Rather, analytical results are compared to potentially relevant criteria, mainly the WVGPS established under Title 47, Series 12, Appendix A, and the DMVs established under the VRP.

#### **4.8.2.1 General Chemistry**

TOC was analyzed on all groundwater samples from all wells, representing a total of up to 17 sampling events. Other general chemistry parameters that were analyzed on samples from 12 monitoring events, beginning in September 2000 through December 2005, include:

- Nitrate-N
- Ammonia-N
- Sulfate
- Ferrous iron
- Dissolved oxygen

Results for general chemistry parameters are summarized in **Table 2**.

Groundwater in the unconsolidated zone beneath the site is characterized by a near neutral pH, typically between 6.0 and 8.0 standard units. The pH values appear consistent among the 10 monitoring wells, indicating there is no effect on pH related to the former DBA and subsequent remediation activities. Sulfate concentrations at monitoring wells MW-101 and MW-110 typically range from around 30 milligrams per liter (mg/L) to around 80 mg/L. In wells near and downgradient from the DBA (e.g., MW-104, MW-105, and MW-106), sulfate values increased substantially in mid-2003, as a result of the in-situ bioremediation program. In the most recent groundwater monitoring events, sulfate values approached those in background wells. Results for nitrate-N exhibit a similar pattern, with concentrations in wells MW-101 and MW-110 commonly less than 0.3 mg/L. TOC values for background wells are typically below 5.0 mg/L. In wells near the DBA, historical TOC values were commonly between 10 mg/L and 100 mg/L, although at most wells, there appears to be an overall decreasing trend.

#### 4.8.2.2 *Metals*

Lead has been analyzed on samples collected during all groundwater sampling events. Metals listed in 40CFR264, Appendix IX and analyzed on samples collected during October 1999 include:

Aluminum*	Calcium*	Magnesium*	Silver
Antimony	Chromium	Manganese*	Sodium*
Arsenic	Cobalt	Mercury	Thallium
Barium*	Copper*	Nickel*	Vanadium*
Beryllium	Iron*	Potassium*	Zinc*
Cadmium	Lead*	Selenium	

Metals detected at one or more monitoring wells are marked with '\*'. **Table 3** provides a summary of results for those metals detected in samples collected during the October 1999 Appendix IX sampling event, along with respective WVGPS and DMVs for groundwater.

Of the metals detected, barium, lead, iron, manganese, and vanadium were reported at concentrations exceeding their respective WVGPS and/or DMV. With one exception, detections of these metals above WVGPS and/or DMVs were limited to monitoring wells MW-104, MW-105, and MW-106 located adjacent to or downgradient from the DBA. Manganese was also reported above its DMV at MW-102, which is along the downgradient Site boundary near the TSS. It is noted that the metals results are for total metals. Such results can reflect, at least in part, suspended sediment in the samples that is digested by the acid used to preserve samples for metals analyses.

#### 4.8.2.3 *VOCs*

VOCs reported in one or more groundwater samples from the site included the following:

Acetone*	Methyl isobutyl ketone (MIBK)*
Benzene*	Tetrachloroethene (PCE)*
Chlorobenzene*	1,1,2,2-Tetrachloroethane (1,1,2,2-TCA)*
1,2-Dichloroethane (1,2-DCA)*	Trichloroethene (TCE)*

1,1-Dichloroethene (1,1-DCE)	Toluene
1,2-Dichloroethene (1,2-DCE)*	Vinyl Chloride*
1,2-Dichloropropane (1,2-DCP)*	Xylenes
Ethylbenzene*	1,1,2-Trichloroethane (1,1,2-TCA)*
Methyl ethyl ketone (MEK)	

**Table 4** provides a summary of those VOCs detected in one or more groundwater samples, along with respective WVGPS and DMV for groundwater. VOCs detected at concentrations above their respective WVGPS and/or DMV at one or more monitoring wells are marked with ‘\*’.

The monitoring wells with the most frequent detections of VOCs above a WVGPS and/or DMV were:

MW-102: 1,2-DCP

MW-104: chlorobenzene

MW-106: TCE, 1,2-DCE, 1,1,2-TCA, benzene, and chlorobenzene

MW-102 is located just southwest of the TSS; MW-104 is located adjacent to the DBA; and MW-106 is located hydraulically downgradient from the DBA. Except for benzene and chlorobenzene at MW-106, concentrations of these VOCs appear to show an overall decreasing trend.

During the June and December 2005 monitoring events, VOCs regulated by condition IV-C-2 of the Post-Closure Care Permit (Modification 002) were reported only in the MW-104 and MW-106 wells. In monitoring wells along the downgradient boundary of the Site (i.e., MW-102, MW-103, MW-107, MW-108, and MW-109), only 1,2-DCP, for which no limit is established under permit condition IV-C-2, was reported above its WVGPS or DMV.

#### 4.8.2.4 SVOCs

SVOCs reported in one or more groundwater samples included:

Aniline*	3-Methylphenol (m-Cresol)
Bis(2-chloroisopropyl)ether*	4-Methylphenol (p-Cresol)
Bis(2-ethylhexyl)phthalate*	1,2-Dichlorobenzene
4-Chloroaniline*	1,4-Dichlorobenzene*
2-Chlorophenol*	2,4-Dimethylphenol
2-Methylphenol (o-Cresol)*	Naphthalene*

**Table 5** provides a summary of those SVOCs detected in one or more groundwater samples, along with respective WVGPS and DMVs for groundwater. SVOCs detected at concentrations above their respective WVGPS and/or DMV at one or more monitoring wells are marked with '\*'.

The monitoring wells with the most frequent detections of SVOCs above WVGPS and/or DMVs were:

MW-104: 2-chlorophenol, 1,4-dichlorobenzene, bis(2-chloroisopropyl)ether, naphthalene

MW-106: bis(2-chloroisopropyl)ether

Of the SVOCs reported in groundwater samples, maximum concentrations were established in the Post-Closure Care Permit for 1,2-dichlorobenzene, 1,4-dichlorobenzene, and bis(2-ethylhexyl)phthalate. Of these, bis(2-ethylhexyl)phthalate was largely below detection in groundwater, with only one reported detection at MW-102 and one at MW-104, both during the September 1999 sampling event. During the June and December 2005 groundwater sampling events, all of these SVOCs were below detection at monitoring wells along the downgradient Site boundary.

The only SVOCs reported above their respective WVGPS and/or DMV during these sampling events were naphthalene at MW-104, and bis(2-chloroisopropyl)ether at MW-106. In cases where SVOCs

were reported relatively consistently at a monitoring well, the long-term trend in concentrations was determined to be downward.

#### ***4.8.2.5 PCBs/Pesticides/Herbicides/Dioxins/Furans***

Groundwater samples collected during the October 1999 sampling event were analyzed for the polychlorinated biphenyls (PCBs), pesticides, herbicides, dioxins, and furans included in 40CFR264, Appendix IX. A summary of the detected compounds is provided in **Table 6**.

Beta-BHC and octafulan (1,2,3,4,6,7,8,9-OCDF) were reported in the sample from monitoring well MW-106. Octadioxin (1,2,3,4,6,7,8,9-OCDD) was reported in samples from all wells except MW-101. The beta-BHC result for MW-106 is above the DMV. The OCDF and OCDD analytical results were converted to total 2,3,7,8-tetrachlorodibenzodioxin (TCDD) toxicity equivalents using applicable toxicity equivalency factors (TEFs) for dioxins and dioxin-like compounds (**Table 6**). The results for all samples were below the DMV. It is noted that the detections of these compounds were not regarded to be substantive and were not incorporated into the permit modification conditions by the WVDEP.



## **5.0 SCOPE OF VRP SITE ASSESSMENT INVESTIGATION**

### **5.1 Objectives**

The primary objectives for the VRP Site Assessment for the former QCI site are as follows:

- Provide survey and legal description of the site;
- Confirm contaminants of interest (COI);
- Confirm the current extent of contamination in soil and groundwater;
- Determine current representative concentrations of COI in soil and groundwater relative to VRP DMVs;
- Determine current concentrations of COI in the TSS relative to RCRA LDRs;
- Identify/confirm potential migration pathways for COI;
- Identify/confirm potential receptors; and
- Provide data for use in ecological and human health risk screening or assessment, as applicable.

### **5.2 Scope of Investigation**

The site assessment included two phases. The initial phase was conducted in accordance with the SAWP, dated June 4, 2012, and included five main tasks:

- Review of historical land use,
- Soil sampling,
- Installation of temporary groundwater sampling points,
- Groundwater sampling, and
- Groundwater flow mapping.

The results from this work were reported to the WVDEP in the SAR, dated December 27, 2012. In response to comments from the WVDEP, dated January 30, 2013, and subsequent discussions with the agency, a SAWP Addendum, dated April 2013, was submitted to the WVDEP for

approval. The addendum included the collection of additional soil samples at selected locations and the installation of one groundwater monitoring well. The specific scope of each of these tasks is described in the following sections.

### **5.2.1 Review of Historical Land Use**

Other than the  $\pm 10$ -acre area between the base of the wooded hillside and Route 25, there is no known previous use of the Site. To confirm that no other solid waste management units or AOCs where hazardous substances or petroleum products may have been released exist on the Site, a review of historical land use for the entire Site was performed. The review included a review of historical aerial photographs and topographic maps, a walking reconnaissance of undeveloped areas of the Site, and inquiries with Mr. Ron Baker (current facility manager), who has been employed at the facility since the mid-1990s.

SAIC engaged INFOMAP Technologies, Inc. to provide historical aerial photographs and topographic maps. Coverage for the following years was provided:

Aerial photographs: 1957, 1971, 1990, 1996, and 2011

Topographic maps: 1899, 1909, 1909 (reprinted 1920), 1931, 1933, 1933 (reprinted 1939), 1958, 1958 (revised 1971), and 1958 (revised 1976)

Copies of the photographs and maps are provided in **Appendices B-1 and B-2**, respectively.

### **5.2.2 Soil Sampling**

#### **5.2.2.1 Former Drum Burial Area**

Soil samples were collected at seven locations at the DBA; designated DBA-1 through DBA 5, DBA-7, and DBA-8. The sampling locations were intended to provide data to represent soil conditions in close proximity to the former excavation. **Figure 5** shows the approximate configuration of the area from which drums and soil were excavated in 1995, along with the soil

sampling locations. Due to repeated refusal of the sampling device within the area of the planned sampling location, no samples were collected at the DBA-6 location.

Soil sampling was performed using direct-push (e.g., Geoprobe®) sampling methods, as described in the SAWP, dated June 4, 2012, and approved by the WVDEP. Continuous soil sampling was performed to a depth of 20 feet or to the top of bedrock, whichever was encountered first. Copies of the boring log forms for the DBA are provided in **Appendix C-1**.

At each location, three soil samples were collected for laboratory analyses, as follows:

1. 0- to 2-foot depth interval to represent surface soil.
2. Because the depth of the excavation area was reported to be up to 18 feet, a soil sample also was collected from the 16- to 18-foot depth interval, or from the last soil interval above bedrock, whichever was encountered first.
3. 6- to 8-foot depth interval, or from the interval with the highest flame ionization detector/photoionization detector (FID/PID) screening result.

All soil samples from the DBA were analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), vanadium, VOCs, and SVOCs (including polynuclear aromatic hydrocarbons [PAHs] compounds). Based on the results of the field PID screening, five soil samples were selected for additional analyses, including pesticides, herbicides, PCBs, dioxins, and furans. Analyses were performed by TestAmerica Laboratories, Inc. (TestAmerica).

#### ***5.2.2.2 Treated Soil Stockpile***

The TSS measures approximately 75 feet by 150 feet. Soil samples were collected at nine locations on the stockpile, designated TSS-1 through TSS-9, as shown in **Figure 6**.

Soil sampling was performed using direct-push (e.g., Geoprobe<sup>®</sup>) sampling methods, as described in the SAWP, dated June 4, 2012, and approved by the WVDEP. Copies of the boring log forms for the TSS are provided in **Appendix C-2**.

At each location, the soil samples from the two depth intervals that yielded the highest readings from the PID scan were collected for laboratory analyses. Soil samples were analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), vanadium, VOCs, and SVOCs (including PAH compounds). Based on the results of these analyses, the soil sample from the TSS-2, 5- to 7-foot depth interval was also analyzed for pesticides/herbicides, PCBs, and dioxins/furans.

#### ***5.2.2.3 Polymer Spill Area***

The approximate location of the Polymer Spill Area (PSA) is shown in **Figure 2**. Soil samples were collected at two locations in this area, designated PSA-1 and PSA-2 (**Figure 7**). Soil sampling was performed using direct-push (e.g., Geoprobe<sup>®</sup>) sampling methods, as described in the SAWP. Copies of the boring log forms for the PSA are provided in **Appendix C-3**.

At each location, two soil samples were collected for laboratory analyses. No positive PID readings were recorded for samples from this area. In accordance with the SAWP, soil samples for laboratory analyses were collected from the 0- to 2-foot and 6- to 8-foot depth intervals. All soil samples from the PSA were analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), vanadium, VOCs, and SVOCs (including PAH compounds).

#### ***5.2.2.4 Wastewater Treatment Plant Area***

The area of soil affected by seepage from the wastewater treatment tank was inspected and reviewed with facility personnel. Soil samples were collected at two locations in this area, designated WWTP-1 and WWTP-2, focusing on areas where it appeared the seepage may have pooled for a period of time (**Figure 4**).

The samples were collected from the upper one foot of soil using manual sampling methods, as described in the SAWP. Copies of the soil descriptions for the WWTP soil samples are provided in **Appendix C-4**. The soil samples were analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), vanadium, VOCs, and SVOCs (including PAH compounds).

#### **5.2.2.5 Disposal Pit Area – AOC No. 1**

Soil samples were collected at two locations (designated WTA-1 and WTA-2) within the area believed to correspond to the reported disposal pit area, just north-northeast of the wastewater treatment area (**Figure 8**).

Soil sampling was performed using direct-push (e.g., Geoprobe<sup>®</sup>) sampling methods, as described in the SAWP. Continuous soil sampling was performed to a depth of 12 feet or to the top of bedrock, whichever was encountered first. Copies of the boring log forms for the WTA locations are provided in **Appendix C-5**.

At each location, three soil samples were collected for laboratory analyses. The samples were collected from the three depth intervals that yielded the highest readings from the PID scan. If no positive PID readings were recorded, soil samples were collected from the 0- to 2-foot, 6- to 8-foot, and 10- to 12-foot depth intervals. If bedrock is encountered, the lowermost sample was collected from immediately above the top of bedrock.

All soil samples from the WTA locations were analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), vanadium, VOCs, and SVOCs (including PAH compounds). Based on results from analyses of these parameters, the samples from the WTA-2 location, 3- to 5-foot and 12- to 13-foot intervals were also analyzed for pesticides/herbicides, PCBs, and dioxins/furans.

### **5.2.3 Installation of Temporary Groundwater Sampling Points**

As requested by WVDEP personnel during a site visit conducted on February 29, 2012, temporary groundwater monitoring points, designated TMP-1 through TMP-3, were installed at the following locations:

- TMP-1: in the polymer spill area;
- TMP-2: midway between existing monitoring wells MW-103 and MW-108; and,
- TMP-3: directly south of the treated soil stockpile.

The SAWP called for a fourth temporary sampling point (TMP-4) to be installed near the southeast corner of the TSS, but this location could not be accessed by the equipment available at the time the other points were installed. Installation of TMP-4 was deferred, pending evaluation of results for groundwater samples from TMP-3.

During the site reconnaissance described in Section 5.2.1, the MW-108 monitoring well (a flush-mount well in a gravel-covered portion of the facility parking lot) could not be located. As an interim measure, a temporary groundwater sampling point (TMP-5) was installed at the approximate location of the MW-108 well.

Approximate locations for the temporary monitoring points are shown in **Figure 4**. Logs from the installation of the points are provided in **Appendix D**.

### **5.2.4 Groundwater Sampling**

Groundwater samples were collected from monitoring wells (MW series and WWT series) and temporary monitoring points (TMP series) on two occasions, August 15-16, 2012, and September 19-20, 2012. Because the MW series monitoring wells were last sampled in 2005, and the last sampling date for the WWT wells is unknown, an attempt was made to redevelop the existing monitoring wells prior to sampling. Well development and sampling procedures were as described in the SAWP.

During the sampling events, the following deviations from the planned sampling program occurred:

August: WWT-1, WWT-2, and TMP-1 did not yield sufficient water for sampling.

September: WWT-2 did not yield sufficient water for sampling. WWT-1 and TMP-1 yielded only sufficient water for collection of samples for VOC analyses.

With the exceptions noted above, all groundwater samples from both sampling events were analyzed for arsenic, barium, lead, iron, manganese, vanadium, VOCs, and SVOCs. Metals were analyzed on both unfiltered and filtered samples.

Groundwater samples from the first sampling event were also analyzed for pesticides/herbicides and PCBs. With two exceptions (see Section 6.5), results for these compounds were below DMVs for all samples from the first sampling event. Based on these results, pesticides/herbicides and PCBs were not analyzed on samples from the second sampling event.

Sampling log forms for both groundwater sampling events are provided in **Appendix E**.

### **5.2.5 Groundwater Flow Mapping**

In conjunction with each groundwater sampling event, depth-to-water measurements were made in all existing monitoring wells and temporary monitoring points. The measurements and reference point elevations for each well/point were used to determine the groundwater elevation at that location. The groundwater elevations were plotted on a site base map and contoured to evaluate horizontal hydraulic gradients and general groundwater flow directions in the unconsolidated zone.

## **5.2.6 Addendum**

### ***5.2.6.1 Disposal Pit Area – AOC No. 1***

To further evaluate the presence and distribution of VOCs and SVOCs in soil in this area, supplemental soil samples were collected at two locations—designated WTA-03 and WTA-04 (see **Figure 8**). The final locations were determined in the field, based on discussions with WVDEP personnel. At the WTA-03 location, soil samples were collected from depth intervals of 0 to 2 feet, 6 to 8 feet, and 9 to 11 feet. At the WTA-04 location, bedrock was encountered at a depth of six feet. Soil samples were collected from the 0 to 2 feet and 4 to 6 feet depth intervals for laboratory analyses. All samples were analyzed for VOCs and SVOCs.

### ***5.2.6.2 Sludge Release Area***

On February 7, 2013, workers at the property discovered that a small volume (approximately 200 gallons) of non-hazardous sludge had been released from a plastic storage tank in the wastewater treatment plant area. The release was reported to the WVDEP. The release did not migrate from the immediate area of the tank. The sludge was covered with a tarp in the event of precipitation that evening. A contractor removed the sludge and several inches of underlying soil on February 8, 2013.

To evaluate soil conditions beneath the area of the sludge release and subsequent cleanup, soil samples were collected at two locations within the area of the spill, designated SRA-SS-01 and SRA-SS-02. Samples were collected from the upper one foot of soil using manual sampling methods, as described in the SAWP. The soil samples were analyzed for VOCs and SVOCs.

### ***5.2.6.3 MW-108 Replacement Well Installation/Sampling***

At the outset of the VRP site characterization in August 2012, in preparation for groundwater sampling, the original MW-108 monitoring well could not be located. To enable collection of groundwater data at that location, a temporary groundwater sampling point (TMP-5) was



installed at the approximate location of the former MW-108 well. To provide further evaluation of groundwater quality in the area downgradient of monitoring wells MW-105 and/or MW-106, a replacement well (designated MW-108R) was installed at a location selected by the WVDEP and approximately indicated on **Figure 4**.

During drilling for the installation of the replacement well, continuous soil sampling was performed from land surface to the top of bedrock, by hollow-stem auger drilling with split-spoon sampling.

The well was constructed through the inner bore of the hollow-stem augers and consisted of 20 feet of 2-inch-diameter 0.010-inch slot, PVC well screen and 2-inch-diameter PVC riser. All joints were threaded. A 2-foot-thick seal, comprised of bentonite chips was installed on top of the sand-packed interval. From the top of the bentonite pellet/chip seal, the borehole annulus was filled with thick bentonite slurry to a depth of about three feet below ground surface. The remainder of the borehole annulus was filled with neat cement to ground surface. A lockable protective casing was installed over the top of the PVC riser.

The well was developed to remove fine sediment that entered the screened interval during installation. Well development was accomplished using a small-diameter electric submersible pump (e.g., Proactive pump) and by hand bailing. Periodically during development, field measurements of pH, specific conductance, turbidity, and temperature were recorded. It is noted that the low water yielding capacity of the well substantially limited the ability to develop the well.

The replacement well was surveyed by a West Virginia-licensed professional surveyor to determine its lateral location and to establish a reference point at the top of the PVC riser for making water-level elevation measurements.

Field log forms related to the drilling, installation, and development of the well are included in **Appendix D**.

The MW-108R well was sampled on June 17, 2013, and again on July 22, 2013. Sampling was performed in accordance with procedures described in the approved SAWP. The samples for both sampling events were analyzed for the metals (total and dissolved), VOCs, and SVOCs analyzed on groundwater samples from the first sampling event under the VRP. The groundwater sampling, chain-of-custody, and analytical procedures were as described in the original SAWP.

## **6.0 DESCRIPTION OF SITE CONDITIONS**

### **6.1 Historical Land Use**

As described in Section 5.2.1, historical land use on the Site was evaluated through a walking reconnaissance of undeveloped portions of the Site and a review of historical aerial photographs and topographic maps.

#### **6.1.1 Reconnaissance**

A walking reconnaissance of the undeveloped portion of the Site was conducted on August 6, 2012. Owing to dense vegetation and steep terrain and associated safety considerations, the reconnaissance focused largely on areas that could be observed from the access road for the communications tower located along the east-central boundary of the Site and all-terrain vehicle (ATV) trails along a portion of the western Site boundary. As described below, the road used to access the communications tower existed prior to the QSI facility (i.e., prior to 1958). Considering this history, the area immediately adjacent to the road is regarded to have the greatest potential for the presence of previously unidentified disposal/dump sites. No evidence of significant disposal activity was observed during the reconnaissance. Representative photographs from the site reconnaissance are provided in **Appendix F**.

#### **6.1.2 Aerial Photographs**

A summary of observations relating to each of the aerial photographs provided by INFOMAP (**Appendix B-1**) is given below.

1957: Image is very dark, so details are hard to discern. Dirt road used to access communications tower is well-defined. Near the south-central limit of the image, a loop-shaped access road is visible at the approximate location of the current QSI facility and wastewater treatment plant. Just east of that location, several structures,

believed to be houses, are visible, at the approximate locations of Parcels 1, 2, 3, and 6 on the current Site survey (see **Figure 2**).

- 1971: Resolution of image is poor. Dirt road used to access communications tower is well defined. Main QSI facility building is visible near south-central margin of image. Presence of structures/houses east of facility is uncertain.
- 1990: Dirt road used to access communications tower is well-defined. Main QSI facility building is visible near south-central margin of image. Wastewater treatment plant appears to be present just north of facility building. Structures/houses east of facility do not appear to be present.
- 1996: Ongoing or recent logging activity apparent over much of the undeveloped portion of the Site. Bio-cells for treatment of soil excavated from DBA visible east of facility building.
- 2011: Communications tower access road less pronounced (overgrown). QSI facility, treatment plant, and truck parking areas in current configuration.

### **6.1.3 Topographic Maps**

A summary of observations relating to each of the topographic maps provided by INFOMAP (**Appendix B-2**) is given below.

- 1899: Road (old Route 25) appears closer to base of valley wall. No development apparent at location of current QSI facility. Single structure indicated in approximate location of current Parcel 6.
- 1909: Single structure indicated at approximate location of current QSI facility (south side of road at that time).
- 1909: (reprinted 1920) Area of the Site unchanged from original 1909 map.
- 1931: Route 25 appears to more closely align with current location. Structure at approximate location of current QSI facility still indicated. Structure at approximate location of current Parcel 6 no longer indicated.
- 1933: Area of the Site appears unchanged from 1931 map.
- 1933: (reprinted 1939) Area of the Site appears unchanged from 1933 map.

- 1958: Structure no longer indicated at approximate location of current QSI facility. Two structures indicated at approximate location of current Parcels 1, 2, 3 and 6 (consistent with 1957 aerial photograph). Road used to access current communications tower indicated. Large industrial complex to the east-southeast of the Site indicated for the first time.
- 1958: (revised 1971) Current QSI facility building indicated. Five structures indicated at approximate location of current Parcels 1, 2, 3 and 6.
- 1958: (revised 1976) Area of the Site unchanged from 1971 map revision.

The reconnaissance and review of aerial photographs and topographic maps described above do not provide any indication of previously unidentified disposal sites or dumps. In addition to these activities, anecdotal evidence provided by Mr. Ron Baker, employed at the QSI facility since the mid-1990s and who periodically hunts and takes walks on the undeveloped portion of the Site, does not indicate the presence of any unidentified disposal or dumping areas.

## **6.2 Hydrology**

The predominant surface water feature in the area of the Site is the Kanawha River, which is some 1,000 to 1,200 feet south of the southern boundary of the Site. Surface drainage from the steep, undeveloped portion of the Site is generally to the south, either by overland flow, or by a deeply-incised natural drainage system that collects surface runoff from much of the upland area. The drainage is routed to a single tributary that exits the upland area near the facility's wastewater treatment plant. At that point, the drainage is routed through an underground pipe (48-inch-diameter) that extends to the south, beneath Route 25. To the south of Route 25, the drainage is by surface ditch to the Kanawha River.

A small area in the northernmost portion of the Site includes part of a surface drainage basin that extends to the north-northeast, to a perennial stream known as Rocky Fork.

The USGS topographic map for the Site (Saint Albans, W. VA., 1976) does not indicate any perennial or intermittent streams on the Site. Long-time facility employees indicate that drainage

from the upland area occurs only during wet seasons or immediately following significant precipitation events.

Runoff from the relatively flat, developed areas of the Site is by overland flow to roadside collection ditches along the north side of Route 25.

### **6.3 Geology/Hydrogeology**

A total of 12 groundwater monitoring wells and five temporary groundwater monitoring points have been installed at the site, including 10 MW series wells (MW-101 through MW-110), two wells designated as WWT-1 and WWT-2, and TMP-1 through TMP-3 and TMP 5. No boring log or well construction information is available for the WWT series wells installed by the WVDEP. Well logs for the MW series wells have been provided to the WVDEP in previous submittals and are provided again as **Appendix G**. Logs for TMP monitoring points are included in **Appendix D**.

#### **6.3.1 Unconsolidated**

The site is immediately underlain by unconsolidated deposits comprised predominantly of varying mixtures of clay, silt, sand, and rock fragments. These deposits represent colluvial material resulting from the weathering of the adjacent bedrock valley wall. At monitoring well locations MW-102, MW-103, and MW-109, more well-sorted sand was recorded near the bottom of the well boreholes, suggesting the lateral margin of Kanawha River alluvial terrace deposits. The unconsolidated deposits overlie bedrock at depths ranging from around 20 feet to around 35 feet below ground surface (bgs). A general geologic cross-section for the Site is shown in **Figure 9**.

During the installation of monitoring wells MW-107 through MW-110 in July 2000, soil samples were collected from the soil/groundwater interface to determine the porosity and bulk density. Results indicate that the porosity of the soils ranges from 29.8 percent to 35.9 percent, and soil density ranges from 1.73 grams per cubic centimeter ( $\text{g/cm}^3$ ) to  $1.86 \text{ g/cm}^3$ . In addition, a soil

sample from a boring drilled near MW-101 was analyzed for TOC content. The resulting value was 3.5 percent TOC.

Based on observations made along steep drainage ways in the undeveloped portion of the Site, upland areas are covered by a relatively thin soil layer, comprised of bedrock residuum and plant matter.

### **6.3.2 Bedrock**

The site is located in the unglaciated portion of the Appalachian Plateau Physiographic Province. Bedrock underlying the site is comprised of the Kanawha Formation of the Pottsville Group. The Kanawha Formation is comprised of alternating beds of siltstone, sandstone, and shale (commonly containing plant debris), coal, and occasionally, thin limestone beds. The bedrock has a well-developed, blocky fracture pattern, which has moderate porosity and permeability.

A rose diagram of bedrock bedding and fracture sets observed and measured at the Site is shown in **Figure 10**. The diagram illustrates fracture orientation and relative degree of development. The bedding strike (intersection of bedding plane with the horizontal) was measured to be generally north 55 degrees east with a dip of 2 degrees to 13 degrees south. Two main fracture trends were measured: north 2 to 32 degrees east and north 10 to 20 degrees west. Both fracture sets were nearly vertical.

### **6.3.3 Groundwater Occurrence and Flow**

The uppermost groundwater beneath the site occurs near the base of the unconsolidated zone. The depth to groundwater is in the range of 15 to 25 feet bgs at most monitoring well locations on the Site. Review of boring logs for monitoring wells suggests that the saturated zone may occur most commonly near the interface between the unconsolidated zone and the top of bedrock, with the saturated zone being on the order of a few feet thick, although groundwater elevations in the wells are somewhat higher. Recharge to the shallow groundwater zone is by infiltration from the surface and by the discharge of groundwater to the unconsolidated deposits

from the underlying bedrock valley wall. By this condition, and consistent with the observation that water levels in monitoring wells are typically somewhat higher than the level where saturation was first observed, the overall vertical hydraulic gradient beneath the developed areas of the Site is interpreted to be upward.

In conjunction with each groundwater sampling event, depth-to-water measurements were made in all existing monitoring wells and temporary monitoring points. The measurements and reference point elevations for each well/point were used to determine the groundwater elevation at that location. Water level elevation data for both monitoring events are summarized in **Table 7**.

The groundwater elevations were plotted on a site base map and contoured to evaluate horizontal hydraulic gradients and general groundwater flow directions in the unconsolidated zone. A representative groundwater elevation contour map for the unconsolidated zone is provided as **Figure 11**. The horizontal hydraulic gradient and direction of groundwater flow in the unconsolidated zone are generally to the south, toward Route 25. In the absence of groundwater pumping in the area, it is expected that groundwater in the unconsolidated zone downgradient from the Site discharges to the Kanawha River.

Results of hydraulic testing conducted in accordance with Modification No. 1 to the Post-Closure Care Permit indicated an average hydraulic conductivity value of 68.62 gallons per day per square foot (gpd/ft<sup>2</sup>) for the unconsolidated zone. The groundwater flow velocity in the unconsolidated zone can be estimated by the equation  $V = Ki/n$ , where:

$V$  = groundwater flow velocity in feet/day

$K$  = hydraulic conductivity feet/day

$i$  = horizontal hydraulic gradient (dimensionless), and

$n$  = effective porosity



For K:

Using a conversion factor of 7.48 gallons per cubic foot (gal/ft<sup>3</sup>), the average hydraulic conductivity (K) converts to 9.17 feet/day.

For i:

From **Figure 11**, the hydraulic gradient calculated between monitoring wells MW-104 and MW-108/TMP-5, directly downgradient from the DBA, is 0.085. This is consistent with the average gradient values calculated between these wells for the groundwater monitoring events performed at the Site from September 2000 through June 2005 (11 events).

For n:

Although the total porosity values obtained for samples from the unconsolidated deposits range from 29.8 percent to 35.9 percent, the effective porosity is typically somewhat lower and often regarded to be equivalent to the specific yield of the deposits. According to Driscoll (1986), the specific yield for clay sediments is typically in the range of 1 to 10 percent, and 10 to 30 percent for sand. Given that the unconsolidated deposits beneath the Site are a mixture of clay, silt, and sand, an overall value of 10 percent is regarded to be reasonable for n.

Based on these input values, the groundwater flow velocity is calculated as:

$$V = 9.17 \text{ ft/day} (0.085)/0.10 = 7.8 \text{ ft/day.}$$

It is noted that the composition of the unconsolidated zone and the horizontal hydraulic gradient are variable beneath the Site. As shown in **Figure 11**, the horizontal hydraulic gradient is generally lower in the area of the TSS. Based on these factors, groundwater flow velocities would be expected to exhibit localized variability.

## 6.4 Analytical Results for Soil

As described in Section 5, soil samples were collected in the following five areas of the developed portion of the Site:

- Former Drum Burial Area (DBA);
- Treated Soil Stockpile (TSS);
- Polymer Spill Area (PSA);
- Wastewater Treatment Plant Area; and,
- Disposal Pit Area – AOC No. 1.

The following sections describe the analytical results for each area. Laboratory data are tabulated according to each area and each category of analyses (e.g., metals, VOCs, SVOCs). In accordance with VRP guidance, a minimum of 10 percent of the laboratory data for soil samples was subjected to Level III data validation. The general criteria used to assess the analytical integrity of the data were based on an examination of: case narrative, analytical holding times, sample preservation, method calibration, method and project blanks, analytical surrogate recoveries, internal standard performance, matrix spike/matrix spike suplicate (MS/MSD) recoveries and differences, laboratory control sample (LCS) recoveries, and re-analysis and secondary dilution recovery. Documentation of the data validation process and findings is provided in **Appendix H**.

To provide a frame of reference and as described in the SAWP, analytical results are compared to VRP DMVs. Two DMVs are given, a risk-based value that assumes incidental direct contact with and ingestion of soil under an industrial land use scenario (i.e., industrial soil value) and a leaching-based value that is regarded to be protective of groundwater (i.e., migration to groundwater value). It is noted that the migration to groundwater value assumes that groundwater potentially impacted by leaching of the contaminants from the soil is used for residential potable supply. For purposes of the discussions in the following sections, this provides a very conservative screening of the analytical results, as there is no known groundwater use in the vicinity of the Site.

With regard to results for metals, analytical results are also compared to natural background levels for soil in West Virginia, as reported in the VRP Guidance Manual (v 2.1).

It is noted that in accordance with paragraph 18 of the VRA, applicable cleanup standards for the site will be determined at a future time, based on the reports to be prepared under the VRA. The future determination of standards will be described in a modification to the VRA.

#### **6.4.1 Former Drum Burial Area**

A total of 21 soil samples were collected from seven locations at the DBA (see **Figure 5**). At each location, soil samples were collected from surface soil (0- to 2-foot depth interval), from a depth interval near or below the base of the former excavation (i.e., 16- to 18-foot depth interval), and from the 6- to 8-foot depth interval or the interval that yielded the highest field PID screening result. All soil samples from the DBA were analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), vanadium, VOCs, and SVOCs (including PAHs compounds). Based on the results of the field PID screening, five soil samples were selected for additional analyses, including pesticides, herbicides, PCBs, dioxins, and furans. The analytical results for the DBA soil samples are provided in **Tables 8 through 13**. To assist in review, sample results exceeding DMVs for each general sample depth interval (i.e., shallow, mid-depth, and deep) are plotted on **Figures 5A through 5C**. The results are discussed in the following sections.

##### **6.4.1.1 Metals (Table 8)**

Barium, cadmium, chromium, lead, mercury, silver, and vanadium were consistently below detection or below their respective DMV in all samples from the DBA. Metals reported above their DMV in one or more samples were arsenic and selenium. None of the reported values for these metals exceeded the risk-based DMV. All of the results exceeding the DMV were above the migration to groundwater value (i.e.,  $DMV_{GW}$ ), which conservatively assumes that groundwater beneath the Site is used for residential potable supply. Results for arsenic and selenium are discussed further in the following paragraphs.

### Arsenic

Arsenic was reported above the  $DMV_{GW}$  (5.8 milligrams per kilogram [mg/kg]) in 12 of 21 samples. All results that exceeded the DMV were within the reported range of natural background levels. The reported range of natural background values for West Virginia soil is 5.9 mg/kg to 13 mg/kg, with a mean of 8.64 mg/kg. The range of arsenic concentrations reported for soil samples from the DBA was 1.9 mg/kg to 12 mg/kg, with 16 of the 21 reported values being below the background mean.

### Selenium

The  $DMV_{GW}$  for selenium is 5.2 mg/kg. The range of natural background concentrations for West Virginia soil is reported to be up to 0.8 mg/kg. Only one result (5.6 mg/kg) for soil samples from the DBA exceeded the  $DMV_{GW}$ . It is noted that selenium was reported in nearly all of the soil samples from the DBA, including samples from all depth intervals, regardless of the relative position of the sample to the former excavation. Also, except for the value of 5.6 mg/kg, the range of reported concentrations was from 1.5 mg/kg to 3.9 mg/kg, which is relatively consistent for an analyte in natural soil. In addition, the selenium values for the DBA soil samples are similar to values reported for soil samples from other areas of the Site where no evidence of impacts was determined (e.g., polymer spill area, described below). Considering these observations, the concentrations of selenium reported for soil samples from the DBA, including the single detection above the  $DMV_{GW}$ , are regarded to represent natural conditions for soil in the local area.

#### **6.4.1.2 VOCs (Table 9)**

VOCs were reported above the sample reporting limits in 12 of 21 soil samples collected in the DBA. A total of 23 different VOCs were reported in at least one sample, with the following 7 compounds reported above their respective DMV in at least one sample:

1,1,2-Trichloroethane	cis-1,2-Dichloroethene	Trichloroethene
Chlorobenzene	Naphthalene	Vinyl Chloride
Chloroform		

All of the results exceeding the DMV were above the  $DMV_{GW}$ . None of the reported values for these VOCs exceeded the risk-based DMV.

The  $DMV_{GW}$  were not exceeded in any of the soil samples from the DBA-2, DBA-3, DBA-4, or DBA-7 locations. At the remaining locations (DBA-1, DBA-5, and DBA-8), the predominant VOCs exceeding their respective standards were chlorobenzene, naphthalene, trichloroethene, cis-1,2-dichloroethene, and vinyl chloride. At both DBA-5 and DBA-8, located within the approximate outline of the former excavation area, the results exceeding  $DMV_{GW}$  were for samples from the 6- to 8-foot and 16- to 18-foot depth intervals.

#### **6.4.1.3 SVOCs (Table 10)**

The only SVOCs reported at concentrations above their sample reporting limits were bis(2-ethylhexyl)phthalate (10 samples), naphthalene (one sample), and 2-methylnaphthalene (one sample). Of these, only the reported result for naphthalene in the 6- to 8-foot sample from the DBA-8 location exceeded its DMV. The result was well below both risk-based value, but above the  $DMV_{GW}$ .

#### **6.4.1.4 Pesticides/Herbicides (Table 11)**

Based on field screenings to identify samples potentially containing relatively high levels of contamination, five samples from the DBA were selected for analysis of pesticide and herbicide compounds. All of the results were below sample reporting limits.

#### **6.4.1.5 PCBs (Table 12)**

Based on field screenings to identify samples potentially containing relatively high levels of contamination, five samples from the DBA were selected for analysis of PCBs. All of the results were below sample reporting limits.

#### **6.4.1.6 Dioxins/Furans (Table 13)**

Based on field screenings to identify samples potentially containing relatively high levels of contamination, five samples from the DBA were selected for analysis of dioxin/furan compounds. The analytical results were converted to total 2,3,7,8-TCDD toxicity equivalents using applicable TEFs for dioxin and dioxin-like compounds. The results for all samples are below the DMV.

### **6.4.2 Treated Soil Stockpile**

A total of 20 soil samples (including two duplicate samples) were collected from nine locations at the TSS (see **Figure 6**). At each location, the soil samples from the two depth intervals that yielded the highest readings from the PID scan were collected for laboratory analyses. All soil samples from the TSS were analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), vanadium, VOCs, and SVOCs (including PAH compounds). These results are given in **Tables 14 through 16**. Based on the results of the field PID screening, the sample from the 5- to 7-foot depth interval at the TSS-7 location was selected for additional analyses, including pesticides, herbicides, PCBs, dioxins, and furans. These are included in **Tables 11 through 13**. To assist in review, sample results exceeding DMVs for each general sample depth interval are shown on **Figures 6A and 6B**. The results are discussed in the following sections.

#### 6.4.2.1 Metals (Table 14)

The only metal reported above its DMV in samples from the TSS was arsenic. Arsenic was reported above the DMV<sub>GW</sub> (5.8 mg/kg) in 17 of 20 samples. None of the arsenic results exceed the risk-based DMV. All results that exceeded the DMV were within the reported range of natural background levels. The reported range of natural background values for West Virginia soil is 5.9 mg/kg to 13 mg/kg, with a mean of 8.64 mg/kg. The range of arsenic concentrations reported for soil samples from the TSS was 3.7 mg/kg to 11 mg/kg, with 17 of the 20 reported values being below the background mean.

Results for the TSS soil samples were also compared to LDRs under the RCRA, specifically, the Universal Treatment Standards under the CFR, Title 40, Subpart D, §268.48. The LDRs are the highest concentration of a substance that can be present in a waste to be eligible for land disposal. In the case of metals, the LDRs are based on the concentration in leachate resulting from the leaching of the waste material using the TCLP. For the metals detected in the TSS soil samples, given below are the LDRs and the range of total metals concentrations reported in the samples.

<b>METAL</b>	<b>LDR (mg/L)</b>	<b>CONCENTRATION RANGE (mg/kg)</b>
Arsenic	5.0	3.7 – 11
Barium	21	30 – 230
Chromium	0.6	14 – 29
Lead	0.75	12 – 23
Mercury	0.025	0.035 – 0.055
Selenium	5.7	1.6 – 4.3
Vanadium	1.6	18 – 47

Although total metals concentrations are not directly comparable to leaching-based LDRs, at the total concentrations reported for each of these metals, it is considered unlikely that these concentrations would yield leachate concentrations exceeding the LDRs.

#### 6.4.2.2 VOCs (Table 15)

VOCs were reported above the sample reporting limits in 17 of 20 soil samples collected in the TSS, including samples from eight of the nine sampling locations. A total of 17 different VOCs were reported in at least one sample. Only naphthalene was reported above its DMV.

All of the results exceeding the DMV were above the  $DMV_{GW}$ ; none of the reported values exceeded the risk-based DMV.

VOC results for the TSS soil samples were also compared to LDRs. VOC concentrations exceeded the LDRs in two samples from the TSS, as summarized below.

VOC	LDR	TSS-2 (5'-7')	TSS-4 (6'-8')
Ethylbenzene	10,000 µg/kg	< LDR	11,000 µg/kg
Naphthalene	5,600 µg/kg	7,400 µg/kg	26,000 µg/kg

#### 6.4.2.3 SVOCs (Table 16)

SVOCs reported in TSS soil samples were 2-methylnaphthalene, bis(2-ethylhexyl)phthalate, naphthalene, and N-nitrosodiphenylamine. None of these compounds exceeded their risk-based DMV. Naphthalene was reported above its  $DMV_{GW}$  in seven samples.

SVOC results for the TSS soil samples also were compared to LDRs, as available. None of the results exceeded LDRs.

#### 6.4.2.4 Pesticides/Herbicides (Table 11)

Based on field screenings to identify samples potentially containing relatively high levels of contamination, the soil sample from the 5- to 7-foot interval at the TSS-2 location was selected for analysis of pesticide and herbicide compounds. Alpha-BHC (0.013 mg/kg) and beta-BHC (0.02 mg/kg) were reported at concentrations exceeding their respective  $DMV_{GW}$  of 0.011 mg/kg



and 0.0043 mg/kg. Both results were well below their respective risk-based DMV, and also well below the LDRs for these compounds (0.066 mg/kg).

#### **6.4.2.5 PCBs (Table 12)**

Based on field screenings, the soil sample from the 5- to 7-foot interval at the TSS-2 location also was selected for analysis of PCBs. All results were below the sample reporting limits.

#### **6.4.2.6 Dioxins/Furans (Table 13)**

Based on field screenings, the soil sample from the 5- to 7-foot interval at the TSS-2 location also was selected for analysis of dioxin/furan compounds. The analytical results were converted to total 2,3,7,8-TCDD toxicity equivalents using applicable TEFs for dioxin and dioxin-like compounds. The resulting value is below the DMV. Individual dioxin and furan compounds detected in the sample were well below their respective LDRs.

### **6.4.3 Polymer Spill Area**

Soil samples were collected at two locations in the PSA, designated PSA-1 and PSA-2 (see **Figure 7**). At each location, two soil samples were collected for laboratory analyses. In accordance with the work plan, soil samples for laboratory analyses were collected from the 0- to 2-foot and 6- to 8-foot depth intervals. A total of five soil samples from the PSA were analyzed, including one duplicate sample. PSA soil samples were analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), vanadium, VOCs, and SVOCs (including PAH compounds). The analytical results for the PSA soil samples are provided in **Tables 17 through 19**. The results are discussed in the following sections.

#### **6.4.3.1 Metals (Table 17)**

The only metal reported above its DMV in soil samples from the PSA was arsenic. Arsenic was reported above the DMV<sub>GW</sub> (5.8 mg/kg) in the two samples from PSA-1. The results that

exceeded the DMV were within the reported range of natural background levels and below the mean background value. The reported range of natural background values for West Virginia soil is 5.9 mg/kg to 13 mg/kg, with a mean of 8.64 mg/kg. The range of arsenic concentrations reported for soil samples from the PSA was 2.9 mg/kg to 6.8 mg/kg.

#### **6.4.3.2 VOCs (Table 18)**

VOCs reported in one or more soil samples from the PSA were acetone, cis-1,2-DCE, trans-1,2-DCE, TCE, and xylenes. None of the results exceeded DMVs.

#### **6.4.3.3 SVOCs (Table 19)**

SVOCs reported in one or more soil samples from the PSA were acetophenone, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, fluoranthene, and pyrene. None of the results exceeded DMVs.

#### **6.4.4 Wastewater Treatment Plant Area**

Soil samples were collected at two locations where it appeared that seepage from the leaking treatment tank may have pooled for a period of time (WWTP-1 and WWTP-2), and from the area of the February 2013 sludge release (SRA-SS-01 and SRA-SS-02). All samples were collected from the upper one foot of soil. The WWTP soil samples were analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), vanadium, VOCs, and SVOCs (including PAH compounds). The SRA soil samples were analyzed for VOCs and SVOCs. The analytical results for the WWTP and SRA soil samples are provided in **Tables 20 through 22**. The results are discussed in the following sections.

#### **6.4.4.1 Metals (Table 20)**

The only metal reported above its DMV in the WWTP soil samples was arsenic. Arsenic was reported above the DMV<sub>GW</sub> (5.8 mg/kg) in the WWTP-1 sample, but the result is within the reported range of natural background levels and below the mean background value.

#### **6.4.4.2 VOCs (Table 21)**

All VOCs analyzed were below detection or below DMVs in the WWTP and SRA soil samples.

#### **6.4.4.3 SVOCs (Table 22)**

Twenty SVOCs, predominantly PAH compounds, were reported in the WWTP and/or SRA soil samples. None of the SVOCs concentrations exceed their respective risk-based DMV or the DMV<sub>GW</sub>. It is noted that PAH compounds are constituents in a variety of common materials, such as coal and asphalt. As such, the isolated detections of certain PAH compounds at concentrations below the DMV<sub>GW</sub>, are not regarded to represent impacts to soil at the WWTP.

#### **6.4.5 Disposal Pit Area – AOC No. 1**

Soil samples were collected at four locations (designated WTA-1 through WTA-4) within the area believed to correspond to the reported disposal pit area, just north-northeast of the wastewater treatment area (see **Figure 8**). At locations WTA-1 through WTA-3, three soil samples were collected for laboratory analyses. At the WTA-4 location, bedrock was encountered at a depth of six feet, so two samples were collected for laboratory analyses. In addition, a field duplicate sample was collected. All soil samples were analyzed for VOCs, and SVOCs (including PAH compounds). Samples from WTA-1 and WTA-2 were also analyzed for RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver) and vanadium. These results are provided in **Tables 23 through 25**. Based on results of field screenings, the samples from the WTA-2 location, 3- to 5-foot and 12- to 13-foot intervals, were also analyzed for pesticides, herbicides, PCBs, dioxins, and furans. These results are included in

**Tables 11 through 13.** To assist in review, sample results exceeding their DMV are shown on **Figures 8A through 8C.** The results are discussed in the following sections.

#### **6.4.5.1 Metals (Table 23)**

The only metal reported in the WTA-1 and WTA-2 samples at concentrations above its DMV was arsenic. All of the results exceeding the DMV were above the migration to groundwater value (i.e.,  $DMV_{GW}$ ), which conservatively assumes that groundwater beneath the Site is used for residential potable supply. Arsenic was reported above the  $DMV_{GW}$  (5.8 mg/kg) in six of the seven samples. All results that exceeded the DMV were within the reported range of natural background levels. The reported range of natural background values for West Virginia soil is 5.9 mg/kg to 13 mg/kg, with a mean of 8.64 mg/kg. The range of arsenic concentrations reported for the WTA soil samples was 4.5 mg/kg to 8.8 mg/kg, with six of the seven reported values being below the background mean. These results are not regarded to represent impacts to soil associated with the alleged disposal pit area.

#### **6.4.5.2 VOCs (Table 24)**

VOCs were not reported in any of the samples from the WTA-1 or WTA-4 locations. A total of 30 different VOCs were reported in the samples from WTA-2 and/or WTA-3. None of the VOCs reported in the WTA-3 samples were above their respective DMV. The following 10 compounds reported above their respective DMV in at least one sample from WTA-2.

1,2-Dichloroethane	Chloroform	Tetrachloroethene
1,2-Dichloropropane	cis-1,2-Dichloroethene	Trichloroethene
Benzene	Naphthalene	Vinyl Chloride
Chlorobenzene		

All of the results exceeding the DMV were above the  $DMV_{GW}$ ; none of the reported values for these VOCs exceeded the risk-based DMV. In general, the highest concentrations of VOCs were reported in the 12- to 13-foot sample.

#### **6.4.5.3 SVOCs (Table 25)**

A total of 23 SVOCs were reported in the WTA soil samples. Concentrations above the DMV were reported only for samples from WTA-2. SVOCs reported above their respective DMV<sub>GW</sub> were bis(2-ethylhexyl)phthalate, naphthalene, and n-nitrosodiphenylamine. SVOC detections were more prevalent and at higher concentrations in the WTA-2 (12- to 13-foot) sample. None of the detected values exceed their risk-based DMV.

#### **6.4.5.4 Pesticides/Herbicides (Table 11)**

Except for alpha-BHC, all pesticide/herbicide compounds were below detection in the WTA soil samples analyzed for this group of parameters. Alpha-BHC was reported in both samples from WTA-2, at concentrations (0.013 mg/kg and 0.018 mg/kg) nominally above the DMV<sub>GW</sub> of 0.011 mg/kg. Neither of these results is above the risk-based DMV.

#### **6.4.5.5 PCBs (Table 12)**

All PCBs were below detection in both WTA soil samples analyzed for this group of parameters.

#### **6.4.5.6 Dioxins/Furans (Table 13)**

The analytical results for dioxin/furan compounds were converted to total 2,3,7,8-TCDD toxicity equivalents using applicable TEFs for dioxin and dioxin-like compounds. The resulting values for both WTA soil samples are below the DMV.

### **6.4.6 Summary of Soil Results**

In all, a total of 67 soil samples (including duplicate samples) were collected from various depth intervals at 26 locations and five areas on the Site where contaminants are known or suspected to have been released to soil.

#### **6.4.6.1 Metals**

RCRA metals and vanadium were analyzed on 59 samples from the Site. Concentrations of barium, cadmium, chromium, lead, mercury, silver, and vanadium were below detection or below their respective DMV in all samples. Selenium was reported above its DMV in only one sample. Arsenic was reported above its DMV in 41 samples. All of the arsenic and selenium results exceeding the DMV were for the migration to groundwater DMV, which conservatively assumes that groundwater beneath the Site is used for residential potable supply. None of the results for these metals were above risk-based DMVs. All of the results for arsenic are within or below natural background concentrations, as reported in the VRP guidance manual. Although one selenium value marginally exceeds the DMV, it is noted that all selenium results for all areas of the Site fall within a fairly narrow concentration range and there is no apparent relationship of higher concentration to potential release locations and/or depth interval. Considering these conditions, the selenium results are regarded to represent natural conditions for soil at the Site. Overall, the analytical results do not indicate impacts to soil at the Site by metals.

#### **6.4.6.2 VOCs**

No VOCs were reported in soil samples from the wastewater treatment plant seepage area or sludge release area, and only low-level detections of a few VOCs were reported for samples from the polymer spill area, with no results exceeding DMVs.

The only VOC exceeding its  $DMV_{GW}$  in samples from the TSS was naphthalene. Naphthalene exceeded the LDR in two samples and ethylbenzene exceeded the LDR in one sample from the TSS.

VOC detections above  $DMV_{GW}$  occurred most predominantly in soil samples from the DBA and the WTA-2 location in the area believed to correspond to a former disposal pit, just north-northeast of the wastewater treatment plant. In these areas, VOCs exceeding  $DMV_{GW}$  were the following:

1,1,2-Trichloroethane	Benzene	Tetrachloroethene
1,2-Dichloroethane	Chlorobenzene	Trichloroethene
cis-1,2-Dichloroethene	Chloroform	Vinyl Chloride
1,2-Dichloropropane	Naphthalene	

None of the detections of VOCs in any of the soil samples from the Site exceeded risk-based DMVs.

#### **6.4.6.3 SVOCs**

SVOC detections above  $DMV_{GW}$  were sporadic. No SVOC detections exceeding  $DMV_{GW}$  were reported for samples from the PSA. SVOCs exceeding  $DMV_{GW}$  in other areas of the Site are the following:

Naphthalene  
Bis(2-ethylhexyl)phthalate  
N-Nitrosodiphenylamine

None of the results for these compounds exceed risk-based DMVs, and none of the results for samples from the TSS exceed applicable LDRs.

#### **6.4.6.4 Pesticides/Herbicides**

Alpha-BHC and beta-BHC were the only pesticide/herbicide compounds reported above their  $DMV_{GW}$ . Both compounds exceeded their  $DMV_{GW}$  in the soil sample from the TSS-2 location. Alpha-BHC was reported above its  $DMV_{GW}$  in both samples analyzed from the WTA locations. None of the results were above risk-based DMVs. None of the results for the TSS exceeded LDR values.

#### **6.4.6.5 PCBs**

PCBs were below detection in all soil samples analyzed.

#### **6.4.6.6 Dioxins/Furans**

Dioxin/furan results were converted to TCDD toxicity equivalents using applicable TEFs for dioxins and dioxin-like compounds. The resulting values for all samples analyzed for dioxin/furan compounds were below DMVs. Results for individual dioxin/furan compounds in the sample from the TSS were below LDR values.

### **6.5 Analytical Results for Groundwater**

As described in Sections 5.2.4 and 5.2.6, groundwater samples were collected from 10 MW series groundwater monitoring wells and three temporary (TMP series) groundwater sampling points. Monitoring wells MW-101 and MW-110 are located hydraulically upgradient from areas of current or previous waste handling (see **Figure 11**). Wells MW-102, MW-103, MW-107, MW-108R, and MW-109, and temporary points TMP-2, TMP-3, and TMP-5 are located along a line just north of and roughly parallel to the downgradient boundary of the Site. Wells MW-104, MW-105, and MW-106, and temporary point TMP-1, are located within or adjacent to known or suspected release areas.

Laboratory data are tabulated according to each category of analyses (e.g., metals, VOCs, SVOCs). In accordance with VRP guidance, a minimum of 10 percent of the laboratory data for soil samples was subjected to Level III data validation. The general criteria used to assess the analytical integrity of the data were based on an examination of: case narrative, analytical holding times, sample preservation, method calibration, method and project blanks, analytical surrogate recoveries, internal standard performance, MS/MSD recoveries and differences, LCS recoveries, and re-analysis and secondary dilution recovery. Documentation of the data validation process and findings is provided in **Appendix H**.

The wells and temporary points were sampled twice. All wells and temporary points except MW-108R, were sampled in August and September 2012. The MW-108R well was sampled in June and July 2013. During each event, samples were analyzed for arsenic, barium, iron, lead, manganese, vanadium, VOCs, and SVOCs. For metals, both field filtered and unfiltered samples



were collected. Samples from the August 2012 sampling event were also analyzed for pesticide/herbicide compounds and PCBs. It is noted that during the August 2012 sampling event, monitoring wells WWT-1 and WWT-2, and temporary point TMP-1, did not yield sufficient water for sampling. During the September event, WWT-1 and TMP-1 yielded sufficient water for analysis of VOCs only. The analytical results for groundwater samples are provided in **Tables 26 through 30**.

The following sections describe the analytical results for groundwater. To provide a frame of reference and as described in the SAWP, analytical results are compared to VRP DMVs. For groundwater, the DMVs assume that groundwater beneath the Site is used for residential potable supply. For purposes of discussions in the following sections, this provides a very conservative screening of the analytical results, as there is no known groundwater use in the vicinity of the Site.

#### **6.5.1 Metals (Table 26)**

Because existing groundwater monitoring wells had not been sampled since 2005, efforts were made to redevelop the wells prior to the August 2012 sampling event. At least several well volumes of water were removed from each well the week before the initial sampling event. Each sampling event also included purging of at least three well volumes of water prior to sample collection at each well. Wells that went dry during purging were sampled upon recovery. Despite redevelopment and pre-sample purging, groundwater from the monitoring wells and temporary points was characterized by varying degrees of turbidity. As a result, metals results for unfiltered samples are regarded to be highly biased by suspended sediment in the samples that is digested by the acid preservative in the sample bottles. The discussions below are based on results for filtered samples.

Results for barium and lead were below DMVs in all groundwater samples collected during both sampling events. Results for arsenic, iron, manganese, and vanadium are discussed in the following paragraphs.

### Arsenic

Arsenic was reported above the DMV (10 micrograms per liter [ $\mu\text{g/L}$ ]) only in samples from the MW-104 and MW-105 monitoring wells, with all results for both of these wells exceeding the DMV. Arsenic results for these wells range from 25  $\mu\text{g/L}$  to 60  $\mu\text{g/L}$ . Arsenic occurs in groundwater in two forms,  $\text{As}^{+5}$  and  $\text{As}^{+3}$ , with the reduced form exhibiting substantially greater solubility. Because arsenic exhibits increased solubility under reducing conditions, it is considered likely that the results reflect the reduced form of arsenic ( $\text{As}^{+3}$ ).

Both MW-104 and MW-105 are located adjacent to the DBA, where the highest concentrations of organic compounds have been historically reported in groundwater at the Site. An increased level of biological activity associated with the degradation of organic compounds can result in reducing (oxygen depleted) conditions in the groundwater. Under these reducing conditions, naturally-occurring arsenic in soil and bedrock would tend to be more soluble. Considering these conditions, the higher levels of arsenic in groundwater in this area of the Site are not interpreted to be directly associated with former disposal or current materials management practices at the Site, but rather, the increased solubility of naturally-occurring arsenic under reducing conditions.

### Iron

Iron was reported above the DMV (26,000  $\mu\text{g/L}$ ) only in samples from MW-105 (75,000  $\mu\text{g/L}$  and 95,000  $\mu\text{g/L}$ ). Iron most typically occurs in groundwater as ferrous iron ( $\text{Fe}^{+2}$ ) and ferric iron ( $\text{Fe}^{+3}$ ), with reduced ferrous iron being the predominant form in solution. Given the concentrations of iron reported for the MW-105 well, it is considered likely that the results reflect the reduced form of iron.

High concentrations of iron, probably reduced ferrous iron, in samples from MW-105 are consistent with arsenic results discussed above. That is, reducing conditions resulting from consumption of dissolved oxygen by the biological degradation of organic compounds in groundwater in that area of the Site supports the occurrence of highly-soluble ferrous iron.

### Manganese

Manganese was reported at concentrations above its DMV in one or both groundwater samples from the following locations: MW-104, MW-105, MW-106, MW-107, MW-108R, TMP-2, and TMP-5. Manganese concentrations above the DMV range from 1,800 µg/L to 5,100 µg/L. Manganese concentrations for samples from monitoring wells MW-101 and MW-110 were less than 1,000 µg/L. In the majority of cases, concentrations for the filtered and unfiltered samples are similar, indicating that manganese concentrations are not heavily biased by turbidity in the samples, unlike other metals analyzed.

### Vanadium

Vanadium was reported at concentrations exceeding the DMV in samples from all downgradient monitoring wells at the Site, except MW-108R. Vanadium was also reported above the DMV in upgradient wells MW-101 and MW-110. Values for the upgradient wells are from 3.6 µg/L to 4.4 µg/L. Except for reported values of 15 µg/L and 12 µg/L for the September 2012 samples from MW-103 and TMP-2, respectively, the range for all other values above the DMV is 2.8 µg/L to 6.7 µg/L. It has been suggested that the presence of high concentrations of ferrous iron may, to some degree, affect the solubility of vanadium, in the form of ferrous vanadate (Hem, 1985). Based on this relationship, the presence of ferrous iron in groundwater at the Site, and the prevalence of vanadium in groundwater across the Site, the reported vanadium values are not regarded to reflect impacts to groundwater directly associated with former or current materials disposal or management practices at the Site.

#### **6.5.2 VOCs (Table 27)**

A total of 22 VOCs were reported in one or more groundwater samples. Of these, the nine VOCs listed below were reported at concentrations above their respective DMV.

COMPOUND	OCCURRENCE SUMMARY		DMV (µg/L)	RANGE EXCEEDING DMV (µg/L)
	# WELLS	OVERALL FREQUENCY >DMV*		
1,1,2-Trichloroethane	1	2/28	5	24 – 25
1,2-Dichloropropane	1	2/28	5	5.6 – 7.9
1,4-Dioxane	1	2/28	0.67	280 – 390
Benzene	3	5/28	5	5.2 – 120
Chlorobenzene	2	4/28	100	1,500 – 4,100
Chloroform	1	2/28	0.19	0.7 – 0.8
cis-1,2-Dichloroethene	2	2/28	70	71 – 120
Trichloroethene	2	3/28	5	49 – 170
Vinyl Chloride	1	2/28	2	5.2 – 5.6

\*-Field duplicates samples treated as single sample for frequency determination.

Except for the two detections of 1,2-dichloropropane and chloroform, all of these reported VOC detections are for samples from monitoring wells MW-104, MW-105, and MW-106, which are adjacent to or immediately downgradient from the former DBA. The detections of 1,2-dichloropropane that nominally exceed the DMV were at monitoring well MW-102. Chloroform was reported at estimated concentrations in the June 2013 sample and field duplicate from MW-108R. No other detections of VOCs exceeding DMVs were reported for sampling locations along the downgradient boundary of the Site. These results indicate minimal potential for the migration of VOCs in groundwater beyond the downgradient boundary of the Site at concentrations exceeding DMV.

**Table 4** provides a historical summary of VOCs most commonly reported in groundwater samples at concentrations exceeding DMVs. Of the four locations where VOCs were reported above DMV during the most recent groundwater sampling events, the recent results are generally consistent with historical conditions at MW-104 and MW-105, which are closest to the DBA. At all other downgradient monitoring wells, including MW-102 and MW-106, VOC results for the recent sampling events are substantially lower than historical values, indicating continued natural degradation/attenuation of VOCs in groundwater at the Site.

### 6.5.3 SVOCs (Table 28)

A total of 31 SVOCs were reported in one or more groundwater samples. Of these, the 10 SVOCs listed below were reported at concentrations above their respective DMV.

COMPOUND	OCCURRENCE SUMMARY		DMV (µg/L)	RANGE EXCEEDING DMV (µg/L)
	# WELLS	OVERALL FREQUENCY >DMV*		
1,4-Dioxane	5	8/26	0.67	0.92 – 190
Benzo(a)anthracene	3	3/26	0.029	0.038 – 1.1
Benzo(a)pyrene	1	1/26	0.2	0.8
Benzo(b)fluoranthene	3	3/26	0.029	0.061 – 1.1
Benzo(k)fluoranthene	1	1/26	0.29	1.2
Bis(2-chloroethyl)ether	2	4/26	0.012	3.3 – 6.9
Dibenz(a,h)anthracene	3	3/26	0.0029	0.036 – 1.2
Hexachlorobutadiene	4	1/26	0.86	1.2
Indeno(1,2,3-cd)pyrene	3	3/26	0.029	0.036 – 1.2
Naphthalene	1	2/26	0.14	23 – 36

\*-Field duplicates samples treated as single sample for frequency determination.

Of these, the PAH compounds, specifically benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene, can be associated with natural materials, such as organic-rich shale and coal, which are both prevalent in bedrock in the Kanawha River valley and can be present in unconsolidated deposits throughout the area. As such, concentrations of these compounds in groundwater samples can be biased by suspended sediment in the samples that is subject to digestion as part of the analytical process. Despite redevelopment and pre-sample purging, groundwater samples from the monitoring wells and temporary points were characterized by varying degrees of turbidity. It is noted that in all cases where PAH compounds were reported above the DMV during the August 2012 sampling event, the corresponding result for the September 2012 sampling event was either below the DMV or substantially lower than the initial result. This is interpreted to indicate continued development of the sampling points with successive purging and sampling events, resulting in decreased turbidity of samples collected during the September event and lower PAH results.

It is also noted that PAH compounds were not detected in groundwater samples collected during routine, semiannual monitoring performed from 1999 through 2005. Purging of the wells two times each year would have resulted in more thorough development of the wells and substantially reduced suspended sediment associated with the samples. Based on the available data, results for PAH compounds are not regarded to reflect impacts to groundwater by PAH compounds associated with prior disposal or materials management at the Site.

Of the remaining SVOC compounds reported above the DMV, 1,4-dioxane was reported in all samples from monitoring wells MW-104, MW-105, and MW-106. These wells are all adjacent to or immediately downgradient from the DBA. Naphthalene also was reported above the DMV only in samples from MW-104. MW-104 is the closest well to the former DBA.

With regard to monitoring wells along or near the downgradient boundary of the Site, detections of SVOCs above DMVs were few and sporadic. 1,4-Dioxane was reported in the September 2012 samples from MW-102 and MW-103; both results of 0.92 µg/L. This result is marginally above the DMV of 0.67 µg/L. Hexachlorobutadiene was reported above its DMV (0.86 µg/L) in the August 2012 sample from MW-102 (1.2 µg/L). The September 2012 sample from MW-102 (0.22 µg/L) was below both the DMV. These results indicate minimal potential for migration of SVOCs in groundwater beyond the downgradient boundary of the Site at concentrations exceeding the DMV.

**Table 5** provides a historical summary of SVOCs reported in groundwater samples at concentrations exceeding the DMV. Only monitoring well MW-104 has a consistent history of SVOC detections, with concentrations exceeding the DMV. Results for the most recent sampling events are generally consistent with historical data for this well.

#### **6.5.4 Pesticides/Herbicides (Table 29)**

None of the pesticide/herbicide compounds were reported at concentrations exceeding their DMV in any of the samples analyzed.

#### **6.5.5 PCBs (Table 30)**

The only PCB result that was above detection was PCB Aroclor 1260 in the sample from MW-102. The reported result of 0.16 µg/L exceeds the DMV of 0.034 µg/L.

## **7.0 CONTAMINANT FATE AND TRANSPORT**

The following sections provide discussions of potential transport pathways for contaminants in soil and groundwater at the Site. These evaluations are considered in the conceptual site model (see Section 8 below) and provide support for the identification and evaluation of potential exposure scenarios (current and hypothetical future) in the Site-Specific Risk Assessment.

### **7.1 Soil**

Primary transport pathways for constituents in soil typically include erosion and transportation as suspended or dissolved material in storm water runoff, erosion and transportation of fine particulate material by wind, and leaching of water-soluble constituents by infiltration. Volatilization and transport into the atmosphere or intrusion into buildings is also a potential transport pathway for VOCs in soil. These potential transport pathways are discussed in the following sections.

#### **7.1.1 Erosion/Storm Water Runoff**

The developed portion of the Site, where contaminants have been detected in soil samples, is largely covered by gravel, except in its eastern end, where it is covered by grasses and light brush. This portion of the Site also is relatively flat, such that the potential for high runoff velocity and associated erosion is reduced. Lastly, data from the soil sampling conducted under the VRP indicates that contaminants are largely non-detect or occur at low levels (e.g., below risk-based DMVs) in surface soil samples (0- to 2-foot depth interval). Based on the combination of these conditions, the potential for transport of contaminants from the Site by way of erosion and storm water runoff is regarded to be negligible.

#### **7.1.2 Erosion/Particulate Emissions**

As discussed above for erosion and storm water runoff, the developed portion of the Site is largely covered by gravel and grass. Contaminants in soil were largely non-detect or below



risk-based DMVs, the derivation of which considers incidental contact with and ingestion of soil particulate, in surface soil samples. Based on the combination of these conditions, the potential for transport of contaminants at the Site by way of wind erosion and particulate emissions is regarded to be negligible.

### **7.1.3 Leaching**

The potential for leaching and transport of water-soluble constituents from soil to groundwater was evaluated by comparing analytical results for soil samples to leaching-based DMVs, and also by the collection and analysis of groundwater samples from a total of 14 locations at the Site, with analyses for selected metals, VOCs, SVOCs, pesticides/herbicides, PCBs, and dioxins/furans.

Certain metals, VOCs, SVOCs, and pesticide/herbicide compounds were reported in soil samples at concentrations above their respective migration to groundwater DMV, indicating a potential for leaching to groundwater to occur. It is noted that these leaching-based values assume that groundwater is used for residential potable supply purposes, but there is no such use of groundwater at or in the vicinity of the Site.

As described in Section 6.5, four metals, nine VOCs, 10 SVOCs, and one PCB Aroclor were reported in at least one groundwater sample at concentrations exceeding its DMV. These data confirm that leaching of water-soluble constituents from soil to groundwater is a transport mechanism at the Site. The migration of dissolved constituents in groundwater is discussed below in Section 7.2.

### **7.1.4 Volatilization**

Concentrations of VOCs in surface soil samples were typically below detection or below DMVs. As such, volatilization from soil to atmospheric air is not regarded to be a significant contaminant transport pathway at the Site. Also, in the development of DMVs, ingestion is regarded to be the primary exposure pathway. However, because VOCs may have a primary route

of exposure other than ingestion (e.g., volatilization), they will be evaluated further through the Site-Specific Risk Assessment, in accordance with VRP guidance.

### **7.1.5 Vapor Intrusion**

Existing facility buildings do not directly overlay and are not immediately adjacent to any of the locations where VOCs were detected in soil samples. As such, the potential for volatilization and intrusion of VOCs into existing Site buildings is regarded to be negligible. Because the areas where VOCs occur in soil are largely flat-lying and could be subject to development in the future, the vapor intrusion migration pathway for a hypothetical future building is a potentially significant pathway and will be evaluated in the Site-Specific Risk Assessment.

## **7.2 Groundwater**

Potential transport pathways relating to groundwater include the movement of dissolved constituents according to hydraulic gradients (i.e., from areas of higher hydraulic potential to areas of lower hydraulic potential), and the volatilization of VOCs from the groundwater and movement through the overlying soil to the atmosphere or into structures. Each of these potential transport pathways are discussed in the following sections.

### **7.2.1 Migration of Dissolved Constituents**

Constituents dissolved in groundwater move according to prevailing groundwater flow patterns, from areas of higher hydraulic potential (higher groundwater elevation) to areas of lower hydraulic potential (lower groundwater elevation). Concentrations typically tend to decrease with distance away from a source and/or time, due to factors such as dilution, degradation, adsorption to aquifer matrix materials, and chemical processes. As discussed in Section 6.3.3, groundwater flow in the unconsolidated deposits beneath the Site is generally to the south. Movement of constituents dissolved in the groundwater beneath the Site would be expected to also be in this direction.

Analytical results for groundwater samples show substantial decreases in concentrations of contaminants, especially VOCs and SVOCs, over relatively short distances downgradient from source areas. More specifically, concentrations of VOCs and SVOCs are much lower at sampling locations MW-108/TMP-5, TMP-2, and MW-103 than at MW-104, MW-105, and MW-106. These data indicate rapid attenuation with groundwater flow distance in the unconsolidated deposits.

As discussed in Section 6.5, analytical results for monitoring points along or near the downgradient boundary of the Site (i.e., MW-102, MW-103, MW-107, MW-108/TMP-5, MW-109, TMP-2, and TMP-3) indicate minimal potential for migration of contaminants in groundwater beyond the downgradient boundary of the Site at concentrations exceeding DMVs. Further, there is no known use of groundwater for potable supply purposes in the vicinity of the Site.

Because the Kanawha River is interpreted to be the discharge point for shallow groundwater in the area, the potential for impacts to the Kanawha River by dissolved constituents migrating in groundwater from beneath the Site was analyzed.

The first step in this analysis was to screen constituents detected in one or more groundwater samples against West Virginia Water Quality Standards (WQS) listed in 47CSR2, Appendix E, Table 1. To provide a conservative screening, the highest concentration reported for any groundwater sample collected during the VRP sampling program, regardless of location on the Site, was compared to the lowest listed WQS. If the highest groundwater concentration did not exceed the lowest WQS, the constituent was not carried further in the analysis. **Table 31** provides a summary of this screening for those constituents detected in groundwater that have WQS established under 47CSR2. It is noted that the WQS provided in **Table 31** reflect the designated use of the Kanawha River, which is a warm water fishery. Although there are no public water supply intakes on the Kanawha River near the Site, WQS values for protection of human health relating to consumption of fish and water are included in **Table 31**.

Constituents in which the highest groundwater concentration exceeded the lowest WQS were further evaluated by application of a “dilution factor.” In this analysis, the volume of groundwater moving from beneath the Site was calculated and compared to the 7Q10 flow volume of the Kanawha River. This comparison was used to determine a “dilution factor” that was then applied to the highest constituent concentrations in groundwater at the Site to produce a theoretical concentration in the river as a result of the groundwater discharge. It is noted that this analysis conservatively assumes that the highest groundwater concentration occurs at the downgradient boundary of the Site and that no degradation or other attenuation of the reported groundwater concentration occurs between the Site and the river, a distance of about 1,500 feet.

The groundwater discharge volume was calculated by the equation  $Q = KIA$ , where:

- Q = groundwater flow in cubic feet per day (ft<sup>3</sup>/d),
- K = hydraulic conductivity (9.17 ft/day, see Section 6.3.3),
- I = horizontal hydraulic gradient (0.085, see Section 6.3.3),
- A = cross-sectional area of aquifer (saturated thickness x length perpendicular to the direction of flow).

The value for saturated thickness was determined using the depth to bedrock and the depth to groundwater at Site monitoring wells. In reviewing boring logs for the monitoring wells at the Site, the borings for five wells were found to have reached bedrock. The data for these wells is summarized below.

WELL	DEPTH TO TOP OF BEDROCK (FT)	DEPTH TO GROUNDWATER (FT) (9/2012)	SATURATED THICKNESS (FT)
MW-101	20.0	17.51	2.49
MW-103	26.7	22.36	4.34
MW-105	31.5	20.04	11.46
MW-106	36.0	20.30	15.70
MW-110	33.0	21.91	11.09

To provide a conservative analysis, a thickness of 15 feet was used.

The length of the groundwater discharge zone perpendicular to the direction of flow was assumed to be the distance between monitoring wells MW-109 and the eastern end of the TSS, a distance of approximately 800 feet. Using this value and a saturated thickness of 15 feet, the cross-sectional area (A) of the groundwater discharge zone is calculated to be 12,000 square feet (ft<sup>2</sup>).

Using this value for A, the volume of groundwater flow from beneath the area of interest at the Site is calculated as follows:

$$Q = KIA$$

$$Q = 9.17 \text{ ft/d} \times 0.085 \times 12,000 \text{ ft}^2$$

$$Q = 9,353 \text{ ft}^3/\text{d}$$

Data regarding the flow of the Kanawha River was obtained from the USGS online Water Information System (WIS) for the gauging station at Charleston, West Virginia. The lowest mean daily flow for a seven-day period for the 10-year period September 1, 2001, through September 30, 2011, was used. The resulting value was 2,030 ft<sup>3</sup> per second (CFS). Converting the calculated groundwater discharge volume to CFS gives 0.108 CFS. Comparing the groundwater discharge rate to the river flow rate, yields a dilution factor of about 18,800.

This dilution factor was then applied to the highest concentration reported for each constituent detected in any of the monitoring wells/points at the Site (regardless of location) during the two groundwater sampling events conducted under the VRP to provide a theoretical in-stream concentration that would result from the discharge of groundwater to the river. For metals, the filtered data were used in the analysis of dissolved contaminant migration. The results are summarized in **Table 31** and show that none of the resulting theoretical in-stream concentrations exceed their lowest WQS value. By this conservative analysis, the migration of dissolved constituents in groundwater beneath the Site is predicted to have negligible effect on surface water in the Kanawha River.

### **7.2.2 Volatilization from Groundwater**

The monitoring wells and sampling points where concentrations of VOCs are reported in groundwater are not immediately adjacent to existing Site buildings. The closest monitoring well to the main facility building is MW-104, which is some 80 feet to the east. As such, the potential for the volatilization of VOCs from groundwater to impact existing Site buildings is regarded to be negligible. As part of the Site-Specific Risk Assessment, the migration of VOCs from soil and groundwater to atmospheric air and to hypothetical future buildings in other areas of the Site by vapor intrusion will be evaluated.

## **8.0 PRELIMINARY CONCEPTUAL SITE MODEL**

As part of the VRP SAWP, a Preliminary Conceptual Site Model (PCSM) was developed to assist in identifying potential COI, contaminant migration pathways, and receptors, and to guide the planning of data collection activities. The PCSM was based on extensive pre-existing data and previous studies relating to groundwater flow, potential contaminant movement in groundwater, and groundwater use in the area.

The following sections provide updates to the PCSM, based on data and associated interpretations from implementation of the VRP SAWP, as described in prior sections of this report. The revised Conceptual Site Model (CSM) will be used to support preparation of the Site-Specific Risk Assessment. A summary of the CSM is provided as **Figure 12**.

### **8.1 Contaminants of Interest (COI)**

The following paragraphs provide a discussion of the identification of specific COI for the Site. The main criteria used in identifying specific COI were the frequency of detection and concentration relative to DMVs. For metals in soil, concentrations relative to the range of natural background concentrations, as reported in VRP guidance, were also considered. As described in Section 6.4, a total of 56 soil samples were collected across the Site. Groundwater samples were collected from 13 locations on two occasions. To provide a conservative initial screening, constituents that were reported in 10 percent or more of the total samples (five or more for soil and two or more for groundwater), regardless of concentration, or the concentration in any one sample that was greater than the DMV were retained as COI for the Site. All other parameters are not retained as COI. Further discussions of the COI are provided in the following sections.

### 8.1.1 Soil

General categories of COI for soil identified in the SAWP were certain metals, VOCs, SVOCs, pesticides/herbicides, PCBs, and dioxins/furans. A summary of the COI evaluation for soil is provided in **Table 32**.

#### Metals

Cadmium and silver were reported infrequently in soil samples and are not retained as COI for soil. Mercury was reported in approximately half of the soil samples, with only one result marginally exceeding the range of natural background concentrations for West Virginia soil, as reported in VRP guidance. As such, mercury is not retained as a COI for soil. Metals reported in nearly all soil samples were arsenic, barium, chromium, lead, selenium, and vanadium. Barium, chromium and vanadium were not reported above their respective DMV and were consistently within or below the reported natural background range for these metals. Therefore, barium, chromium and vanadium are not retained as COI. Although a majority of the arsenic values exceeded the leaching-based DMV, all results were within the reported range of natural background concentrations, so arsenic is not retained as a COI for soil. None of the reported lead concentrations exceeded its DMV, but 12 results exceeded the reported background concentration range. For selenium, all reported concentrations exceeded the reported background concentration; although, only one result exceeded the leaching based DMV. Based on these results, lead and selenium are the only metals retained as COI for soil at the Site.

#### VOCs

A total of 32 VOCs were reported in one or more soil samples. Of these, 23 VOCs were reported in greater than 10 percent of the soil samples. None of the VOC concentrations exceeded the risk-based DMV. In some cases, few or none of the reported concentrations exceeded the leaching-based DMV. However, due to the frequency of detection, these 23 VOCs are retained as COI. In addition, 1,1,2-trichloroethane and tetrachloroethane, which were reported above their respective leaching-based DMV in one sample, are retained as COI.



### SVOCs

A total of 26 SVOCs were reported in one or more soil samples. Of these, three were reported in more than 10 percent of the soil samples, 2-methylnaphthalene, bis(2-ethylhexyl)phthalate, and naphthalene. None of the concentrations exceeded the risk-based DMV, although concentrations of naphthalene and bis(2-ethylhexyl)phthalate exceeded the leaching-based DMV in eight samples and one sample, respectively. These three compounds are retained as COI for soil. In addition, N-nitrosodidiphenylamine, which was reported above its leaching-based DMV in one sample, is retained as a COI.

### Pesticides/Herbicides

Of the pesticide/herbicide compounds, alpha-BHC was reported in three soil samples and beta-BHC was reported in one sample. All of the reported concentrations were a factor of 200 or more below the risk-based DMV. These compounds are not retained as COI for soil at the Site.

### PCBs

PCBs were below detection in all soil samples analyzed and are not retained as COI for soil.

### Dioxins/Furans

One or more dioxin/furan compounds were reported in all soil samples analyzed for these compounds. Dioxin/furan results were converted to TCDD toxicity equivalents using applicable TEFs for dioxins and dioxin-like compounds. The resulting values for all samples were below DMVs. Because results for certain individual dioxin/furan compounds were above their respective DMV prior to conversion, dioxins/furans are retained as COI for soil.

### 8.1.2 Groundwater

Under the approved SAWP and addendum, groundwater samples from the Site were analyzed for selected metals, VOCs, SVOCs, pesticides/herbicides, and PCBs. For each of these categories of constituents, identification of COI for groundwater is discussed in the following sections.

#### Metals

Metals analyzed for in groundwater samples were arsenic, barium, iron, lead, manganese, and vanadium. Results for barium and lead were below DMVs in all groundwater samples collected and are not retained as COI for groundwater. Arsenic, iron, manganese, and vanadium were above DMVs in samples from certain monitoring wells. Of these, vanadium concentrations from sampling locations near or downgradient from known or suspected release areas were generally similar to samples from upgradient sampling locations. Based on these results, vanadium is not retained as a COI for groundwater. Arsenic, iron, and manganese are retained as COI, even though concentrations of these metals in groundwater are not regarded to be directly related to former or current materials disposal or management practices at the Site.

#### VOCs

A total of 22 VOCs were reported in one or more groundwater samples, with nine VOCs reported at concentrations above their respective DMV and are retained as COI. These VOCs are given below.

1,1,2-Trichloroethane	cis-1,2-Dichloroethene
1,2-Dichloropropane	Chloroform
1,4-Dioxane	Trichloroethene
Benzene	Vinyl Chloride
Chlorobenzene	

## SVOCs

A total of 31 SVOCs were reported in one or more groundwater samples, with 10 SVOCs reported at concentrations above their respective DMV. As discussed in Section 6.5.3, concentrations of six PAH compounds in groundwater samples are interpreted to reflect naturally occurring aquifer matrix materials in the form of suspended sediment in the groundwater samples. The remaining four SVOCs retained as COI for groundwater are given below.

1,4-Dioxane  
Bis(2-chloroethyl)ether  
Hexachlorobutadiene  
Naphthalene

## Pesticides/Herbicides

None of the pesticide/herbicide compounds were reported at concentrations exceeding their DMV, so none of these compounds are retained as COI for groundwater.

## PCBs

Only one PCB result (Aroclor 1260 in one sample) was above detection in groundwater samples. Because the result is more than a factor of four greater than the DMV, PCBs are retained as COI for groundwater.

## **8.2 Potential Exposure Pathways – Human Receptors**

Pathways for potential exposure of both human and ecological receptors to COI in environmental media at the Site have been evaluated. As described in Section 7, the media of primary consideration at the Site are soil and groundwater. Analysis of the migration of dissolved constituents in groundwater indicates that the potential for impacts to surface water in the Kanawha River is negligible; therefore, surface water is not retained for further analysis.

Discussion of potential exposure pathways relating to soil and groundwater are given in the following sections.

### **8.2.1 Soil**

The current and foreseeable future use of the portion of the Site where releases have occurred is industrial. Because the transport of soil from the Site by surface water runoff and/or wind is regarded to be low (Section 7.1), the potential for exposure of off-site receptors is negligible. By these conditions, exposure to COI in soil at the Site is most likely by day-to-day workers or by visitors. Exposure to surface and sub-surface soil by excavation workers could also occur, in the event of a construction project, utility repair, or other activity that requires excavation. Based on the evaluation of potential transport pathways provided in Section 7, reasonably anticipated exposure pathways for these receptors include the following:

- Direct contact with surface soil – daily worker, excavation worker, visitor;
- Incidental ingestion of surface soil – daily worker, excavation worker, visitor;
- Inhalation of VOCs from soil to ambient air – daily worker, excavation worker, visitor; and,
- Intrusion and inhalation of VOCs in indoor air of a hypothetical future building constructed over areas of soil contamination – daily worker, visitor.

### **8.2.2 Groundwater**

There is no current groundwater use at or in the vicinity of the Site and the Site and immediate area (to a distance of at least 2,500 feet) are served by a public water supply. As such, exposure pathways related to use of groundwater for potable supply purposes (ingestion, dermal contact, inhalation of vapors) are not complete. As described in Section 7.2, volatilization of VOCs from groundwater and intrusion to indoor air of a hypothetical future building constructed over the areas where VOCs are present in groundwater is a potentially complete exposure pathway for site workers or visitors. Also, because groundwater is relatively shallow beneath some areas of

the Site, there is a potential for workers involved in an excavation project to be exposed to shallow groundwater by direct contact, incidental ingestion, and inhalation of vapors.

### **8.3 Potential Exposure Pathways – Ecological Receptors**

The western portion of the developed area of the Site and the area around the main facility building are covered by gravel and used as parking for tractor trailer trucks. As such, these areas do not represent quality habitat for potential ecological receptors. The eastern portion of the developed area of the Site is covered by grasses and light brush and could serve as habitat for potential ecological receptors. Potential sources of COI in this area of the Site include the former bio-cell soil treatment areas and the TSS. The former bio-cells were excavated and much of the soil was sent off-site for disposal. Excavated soil that was not sent for off-site disposal was consolidated in the TSS and covered with a vegetated soil cover, as approved by the WVDEP and USEPA. As such, the potential for ecological receptors to contact COI in soil at the Site is regarded to be negligible. As described in Section 7.2.1, analysis of the migration of dissolved constituents in groundwater indicates that the potential for impacts to surface water and associated ecological receptors in the Kanawha River is negligible.